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HENRY S. GRAVES, Forester.

USES OF COMMERCIAL WOODS OF THE UNITED STATES:

I. CEDARS, CYPRESSES, AND SEQUOIAS.

BY

WILLIAM L. HALL,

ASSISTANT FORESTER,

AND

HU MAXWELL,

EXPERT.

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UNITED STATES DEPARTMENT OF AGRICULTURE,
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Washington, D. C., April 11, 1911.

SIR: I have the honor to transmit herewith a manuscript entitled "Uses of Commercial Woods of the United States: I. Cedars, Cypresses, and Sequoias," by William L. Hall, Assistant Forester, and Hu Maxwell, Expert, and to recommend its publication as Bulletin 95 of the Forest Service.

Respectfully,

HENRY S. GRAVES,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

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USES OF COMMERCIAL WOODS OF THE UNITED STATES.

INTRODUCTION.

Our forests have been so extensive, so widely separated, and so full of woods of diverse qualities that we have succeeded in compiling only the most categorical lists of the uses to which the various woods are put. The qualities of our better-known woods are, of course, well understood by those who handle them, and their properties have been stated by different writers. Their uses, which differ much under different conditions, are also recorded, but the records are scattered far and wide in books, Government reports, unpublished lectures and papers, and trade journals. The need has therefore arisen to bring together in convenient form the available information on the uses of the different commercial woods, and this the Forest Service has planned to do in a series of bulletins, of which this is the first. The series, it is believed, will be of especial interest to lumbermen and those engaged in the wood-using industries, to foresters, and to instructors and students in forest schools.

The material has been collected from many and widely scattered sources, covering the period from the earliest settlement of the country to the present time, and embracing all parts of continental United States. Recourse has been had to books of early exploration and travel; industrial histories of regions, localities, and cities; commercial and trade reports, statistics, and compilations; technical studies of trades, crafts, manufacturing, and of expositions; and files of journals and periodicals which deal with wood, or the wood-consuming industries, or with related subjects. Original data collected by the Forest Service have also been liberally used.

In the arrangement followed each species is considered separately, and the attempt has been made correctly to describe the uses made of each wood from the earliest times. Present conditions in the wood-consuming industries and the multitudes of uses for which the different woods have been found suitable have been slowly evolved. No one man and no single generation could work out all the uses of a wood. The pioneer quickly learned which of the scores of woods about him he could best use to supply his special needs, under his special conditions. One by one, as he needed them, he put them into

service, and discovered new ones as his wants increased. The manufacture of wood grew from that beginning, and on that same principle it is growing still, with new uses being added and with other kinds of wood being made available as the need arises.

In order to show the basis upon which the uses oi a wood rest, the plan is followed of stating first what is known authentically in regard to the physical properties of each species. This is drawn in part from practical experience of the trades and in part from the investigations of the Government, which have been carried on through a number of years, the first having been made by Sargent in connection with the census of 1880. The later investigations have been carried on by the Forest Service during two distinct periods, the first extending over several years preceding 1897, the last continuing from 1903 to the present time. Sargent's tests covered nearly all the commercial woods of the United States and were made on pieces of the same size and approximately the same moisture content. Although the number of tests for some species was small, it is considered best in this connection to use them, except where the later tests have been made under conditions so similar that the results may safely be compared. For weight, specific gravity, ash, and fuel value the figures of Sargent are as complete and accurate as any later ones, and are here used exclusively.

PHYSICAL PROPERTIES OF WOOD DEFINED.

Since it is necessary in discussing the physical properties of wood to use technical terms, it is proper first to define them and explain as clearly as possible the sense in which they are used.

WEIGHT.

Weight is expressed in terms of a cubic foot of oven-dry wood, calculated from small specimens exposed to a temperature of 100° C. until they cease to lose in weight. While but one value is given, it is the average of a number of specimens, for the variation in weight in the same species is large. This variation could best be shown by giving a range of weights, as some writers have done. Figures showing the range for American woods, however, are wanting, nor does a range of values give any idea of the correct figure to use in calculations. For these reasons it is considered best to give a single figure representing the average of the accurately weighed specimens in Sargent's investigations.

SPECIFIC GRAVITY.

A wood's specific gravity is its dry weight compared with the weight of an equal volume of water at a temperature of 62° F. A cubic foot of water at that temperature weighs 62.355 pounds. If a

cubic foot of wood weighs 30 pounds, its specific gravity is found by dividing 30 by 62.355.

ASH.

When wood is burned until it ceases to lose weight, that which remains is the ash. Its proportion to the dry weight of the wood ranges from one-twelfth or more to considerably less than one one-hundredth. In Sargent's work, the figures of which are here used, an average of the ash of all the specimens taken from the same tree was made, and the average of these averages is given as the final result for the species.

FUEL VALUE.

The fuel values of different woods are fairly well proportioned to their dry weights, with the exception that resinous woods, weight for weight, are higher in fuel value than hardwoods. Sargent's figures are the only ones available, and are used in all cases.

STRENGTH.

The term modulus of rupture is used to express the breaking strength of wood when tested as a beam. It is the measure of a wood's ability to sustain a load. If a beam is supported at the ends and a load is applied at the center and increased until the beam breaks, the load at the breaking would represent its strength. The load stated in pounds per square inch in the cross section of the stick would be its modulus of rupture. Modulus of rupture resulting from a bending test is usually recognized as the best index of the strength of a wood, and on that account is here used. Different woods vary greatly in strength, and specimens from different trees of the same species, or even from the same tree, show wide difference. On this account it is necessary to test many samples, sometimes hundreds, in order to get a reliable average of strength. The modulus of rupture ranges from 5,000 pounds or less per square inch in the weaker woods to 15,000 or more in the stronger. The modulus of rupture of a wood, under average conditions, is approximately equivalent to a load sufficient, if applied to the center, to break a stick 2⅝ inches square, supported on a 12-inch span. For example, if white oak's modulus of rupture is 8,500 pounds, that load would be required to break a white-oak stick of the specified size. In a piece of green wood the moisture content may be as much as 100 per cent of the dry weight, while in air-dry wood the moisture is reduced to 12 or 15 per cent. As the moisture is reduced below 25 or 30 per cent, strength greatly increases. Wood dried to a moisture percentage of 3 or 4 may be three or four times as strong as when green. For

this reason it is important to state the moisture content in giving figures to show a wood's strength. The size of the stick or beam tested has something to do with determining its breaking strength. A small beam is usually stronger in proportion to the area of its cross section than a large one. The apparent difference in favor of the small stick is doubtless due to the smaller proportionate number of defects it contains.

In the recent tests the specimens which furnished the figures here used were clear of knots, 2 by 2 inches in cross section and 30 inches long. In the earlier tests by the Forest Service, the specimens used were 4 by 4 inches in cross section and 60 inches long. The specimens tested by Sargent were 4 centimeters (1.5748 inches) square and 1 meter (39.37 inches) long, and were fully air-dried, as were also the specimens in the earlier tests of the Forest Service. This accounts for the higher values of the woods under those tests compared with the woods tested recently. The latter were often tested more or less green, but the moisture content was accurately determined.

STIFFNESS.

Stiffness is the resistance of a material to deformation under a given load. If a piece of wood 2 by 2 inches and 30 inches long is supported at the ends, and a load is applied at the center, the tendency of the stick to resist bending is its stiffness or elasticity. Suppose that under the load the stick bends one-eighth inch; then if the load is doubled the deflection will be twice as much, or one-fourth inch. If further increases are made in the load, a point is finally reached where more than corresponding deflection results. This point is known as the elastic limit. The measure of stiffness is the modulus of elasticity, which is defined as the measure of the ability of a specimen to resist deformation within its elastic limit.

CHARACTER AND QUALITIES.

Under this heading the attempt is made to sum up in as simple terms as possible the character of the wood and the qualities which form the basis of its utilization. Most of the terms employed are so simple as to require no explanation. Certain of them are used in a restrictive sense which should be noted.

If a wood's weight is less than 30 pounds per cubic foot it is considered light; if between 30 and 40 pounds, medium light or medium heavy; and if over 40 pounds, heavy.

No definite scale of hardness has as yet been arranged for American woods. In fact, tests which might form the basis of such a scale are lacking. It is therefore necessary to resort to indefinite descriptive terms to convey such information as is known.

Grain is here used to designate the structural composition of wood, resulting from the form, size, arrangement, and direction of its component elements of fibers and vessels.[1] According to this usage, grain takes account only of the assembling of the different elements within the layers of annual growth. It does not refer to the width of the annual rings, except as the width or narrowness of these may, to a limited degree, affect characteristically the grain. The component elements of wood have distinctive form and arrangement which vary within limits characteristic of different groups or species. It is these that give character to the grain. If the fibers and vessels which make up a wood are small, the wood is considered fine grained; if relatively large it is coarse grained.' When the vessels and fibers are evenly distributed, the condition is described as even grained, while the opposite condition would be uneven grained. Where the direction of the elements is parallel to the axis of the tree, the wood is called straight grained; when they interlock and are not constant in one general direction, we express the condition as cross grained. Again, if they assume a wavy or curly condition, we accordingly designate the wood as wavy or curly grained. In many trees the elements run spirally around the axis, in which case it is proper to speak of the wood as spiral grained.

This usage in designating the grain of wood differs somewhat from the popular conception, but the word as popularly used lacks constant meaning. Sometimes it refers to the above-named properties, sometimes to rings of annual growth, and again to medullary rays and even to hardness. Often it is used without specific meaning and refers loosely to all of these things.

While grain manifestly should not refer to the rings of annual growth, it is fundamentally influenced by the bands of spring and summer wood which make up the rings, since those bands result from the different association of the elements. Also, grain may be considered as being influenced by the medullary rays, since these, too, present a characteristic form and association of elements. It is necessary, however, to describe these characters specifically, as the terms mentioned above do not adequately designate them.

While grain is only properly described by the use of terms such as those defined, it is entirely natural that the woodworker should base his descriptive terms upon the qualtities which are most important to him. To the handle worker smoothness is an essential quality, and he usually finds it in a fine-grained hard wood, such as hickory, pear, or maple. It is perfectly natural for him to judge a wood not by its fineness, but by the smoothness with which he can cut and polish

[1] For the basis of this definition and for the discussion of grain which follows, the authors are indebted in large degree to Mr. George B. Sudworth and Mr. C. D. Mell, of the Forest Service.

its surface. The pattern maker judges a wood by the ease and evenness with which his tools will cut it, both with and across the grain. His idea of grain is associated with the way in which the wood cuts. The furniture maker's idea of grain goes further than that of the handle maker or the pattern maker. He takes into account the wood's appearance when it is cut in either tangential or radial section, or oblique to the radius. On account of the prominently developed medullary rays in woods such as the oaks, quarter sawing is resorted to in order to enhance the appearance of the resulting surface by exposing to view streaks or patches of the bright, smooth rays. Consequently, the medullary rays frequently become an important factor in the furniture maker's idea of grain. Such surface characters are perhaps better designated as figure.

In color, woods range from white, as in the case of holly, to very black, as in ebony, with practically all intermediate colors and tints. Enough of the coloring matter of some woods—redwood for example—may be worked out with water to impart color to the water. The color of others can be removed only by chemical action, and then only to a small extent unless the wood is first reduced to pulp. Unless otherwise stated, the color refers always to that of a fresh cross section of a piece of dry wood. In certain woods, such as black walnut, mahogany, and redwood, color is a most valuable quality. In others the lack of color is prized. This is especially true of woods used for pulp.

By durability is meant the resistance of wood to decay under conditions favorable to the growth of decay-producing fungi. In order for the fungi to operate, there must be a food supply, air, moisture, and heat. Under constant extreme conditions of moisture or dryness decay does not take place. Wooden coffins in the Egyptian tombs, which have remained perpetually dry, have lasted for ages; so have logs in the swamps which have remained constantly wet. That a wood has not decayed under such conditions is nothing in its favor. Decay simply has no opportunity to take place. Under the dry conditions it was prevented by lack of moisture, and under the wet by lack of oxygen. Between the extreme conditions of constantly wet and constantly dry, decay may take place. One set of conditions may be very much more favorable for decay than another. We can not, on that account, accurately compare the durability of two woods in different localities or under different conditions. They must be side by side and subjected to the same conditions. Certain of our woods are noted for their durability. Before they can be arranged in order, however, they must be tested under the same conditions, and this has not yet been done. It is impossible, therefore, to refer woods to a definite scale in discussing their durability. We can only state with considerable indefiniteness whether they rank among the durable ones or among those which do not resist decay.

GROWTH.

The growth of a tree, as the term is here used, means its average size at maturity attained within its commercial range under ordinary conditions.

THE CEDARS.

Every region of the United States produces one or more species of cedar in sufficient quantity to be of use. Considered as a source of lumber and wood supply, the more important are:

Southern white cedar (*Chamæcyparis thyoides*).
Northern white cedar (*Thuja occidentalis*).
Red cedar (*Juniperus virginiana*).
Western juniper (*Juniperus occidentalis*).
Incense cedar (*Libocedrus decurrens*).
Port Orford cedar (*Chamæcyparis lawsoniana*).
Yellow cedar (*Chamæcyparis nootkatensis*).
Western red cedar (*Thuja plicata*).

A few other species contribute to the lumber supply in different regions, but not to a large extent. Broadly defined boundaries may be described for each of the cedars, although the commercial ranges occasionally overlap. The northern white cedar reaches its best development in the Lake States; the southern white cedar near the Atlantic coast between New York and Florida. The red cedar ranges over the eastern half of the United States, but the most valuable cut now comes from States south of the Ohio River. Western juniper and closely related species are found from the northwest Rocky Mountain region to the Pacific coast. Incense cedar is cut in California and Port Orford cedar in southwestern Oregon. Yellow cedar and western red cedar reach their best development in Oregon and Washington, but their commercial range extends to southern Alaska.

Although the eight species here given botanically represent four genera, all are more or less commonly known by lumbermen as cedars. This is doubtless due to the general similarity of appearance of the growing trees, to the numerous common characteristics of their wood, and to the similar uses to which they are adapted. In statistical reports all of these woods are grouped under the name of cedar. In published statistics one species can be distinguished from another only by the region from which it comes. This is not a safe guide. Red cedar and southern white cedar, for example, occupy in part the same territory, and the same chance for confusion exists with the western red cedar and the yellow cedar, and others. If one can examine the wood, however, there is less danger of confusion, as some species are entirely distinct, and all can usually be readily distinguished.

Southern White Cedar.

(*Chamæcyparis thyoides.*)

PHYSICAL PROPERTIES.

Weight of dry wood.—20.7 pounds per cubic foot. (Sargent.)

Specific gravity.—0.33. (Sargent.)

Ash.—0.33 per cent weight of dry wood. (Sargent.)

Fuel value.—44 per cent that of white oak. (Sargent.)

Breaking strength (modulus of rupture).—6,300 pounds per square inch on pieces 4 by 4 by 60 inches, with 12 per cent of moisture. (Forest Service Circular 15.)

Factor of stiffness (modulus of elasticity).—910,000 pounds per square inch. (Forest Service Circular 15.)

Character and qualities.—Very light, soft, comparatively weak; grain fine, even, and straight; compact; annual rings narrow as a result of slow growth; summerwood thin, dark-colored, conspicuous; medullary rays numerous, obscure; color light brown, tinged with red, growing darker with exposure, the sapwood lighter; easily worked; very durable in contact with the ground.

Growth.—Height 75 to 80 feet; diameter 2 to 4 feet, though latter is exceptional.

SUPPLY.

Twelve or more States contribute to the supply of white cedar, but the annual cut is not known, because this species is not listed separately, but goes to the market with half a dozen other species under the common name of cedar. The States which furnish most of the supply are Delaware, Florida, Georgia, Maryland, New Jersey, North Carolina, South Carolina, and Virginia.

The cut of all woods listed as cedar in the United States in 1907 was 250,000,000 feet, exclusive of poles and ties; but certainly less than one-sixth of this was southern white cedar. Sixty-three per cent of all the telegraph and telephone poles purchased that year in the United States were cedar, but again the proportion that should be credited to southern white cedar is not known.

The value of southern white cedar for many purposes is so well understood that the demand is heavy, and the annual cut greatly exceeds the growth. This is apparent in a general survey of the country and the lumber operations, but exact figures showing remaining stands are as hard to obtain as those which show the yearly cut. It is certain, however, that the remaining supply is very small in comparison with the original stands in the forests which fringed the Atlantic coast from Maine to Florida and westward near the Gulf to Mississippi.

In some particulars southern white cedar has been more fortunate than most commercial timbers in the eastern part of the United States. Less of it has been wantonly destroyed, or cut and burned to make room for agricultural crops. This was because it grew on land too wet for the plow, and under most conditions too wet for forest fires. There was little cutting of white cedar to make room for the garden and cornfield of the settlers. The untillable and frequently impenetrable swamps where it grew protected it. Not even the cypress could compete with it for the possession of water-soaked morasses.[1]

The cutting of this cedar began probably 300 years ago and was in full blast in New Jersey two centuries ago. It was drawn upon for supplies all the way from New England to Florida, but New Jersey has always been a center for its lumber, and the quantity drawn from the swamps of that State, first and last, has been very large. Nearly 200 years ago John Lawson listed its uses in the Carolinas as " Yards, topmast, booms, and bowsprits for boats, and shingles and pails." More than 160 years ago the drain had become so great that fears of exhaustion of supply were freely expressed. Gottleib Mittelberger then declared that at the rate of use in his time the end was in sight; and Benjamin Franklin published an essay in which he advocated forestry methods, especially the planting of red cedar to supply the country when the white cedar and other woods should fail.[2] A year or two later Peter Kalm, a Swedish naturalist traveling in America, foretold the inadequacy of the white cedar forests to meet demands in the near future. Seventy years after that time, however, William Cobbett, an English traveler, declared, but with evident exaggeration, that " all the good houses in the United States " were covered with white cedar shingles.

Southern white cedar is in the peculiar class with mesquite in that a considerable part of the timber comes from beneath the surface of the ground. About 100 years ago the mining of white cedar logs began in New Jersey, and is still in progress. Forests that flourished centuries ago fell in the swamps where they grew and the trunks sank beneath the water and mire. Many of them decayed but little or not at all, and when brought to the surface were found fit for shingles or lumber. Trunks 6 feet in diameter were occasionally found, and the position of some trunks under many superimposed trees and roots indicated that they had lain submerged during many centuries.

White cedar does not promise great things for the future. It can never be extensively and profitably planted, because its range has been pretty definitely fixed by nature to the deep swamps and miry marshes near the coast. Within these bounds, however, it may con-

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1 " The North American Sylva "—A. B. Michaux and Thomas Nuttall.

2 Poor Richard's Almanack, 1749.

tinue for a long time to be of some importance. In some of the swamps where it is found little else that is profitable to man will grow. Such swamps might be kept perpetually in cedar, though the trees grow slowly. Crop after crop of some other trees may be planted and harvested elsewhere, while a single stand of white cedar attains even respectable pole size. Fifty years may be required to produce a fence post. A swamp in New Jersey in which all the timber was killed required half a century to grow posts from seed. It may be expected, however, that supplies will be got for years from southern and eastern swamps, but the quantity and quality harvested in early years need not be looked for again. Rather than be kept for cedar production it is far more likely that the next few decades will see the eastern swamps drained and turned to the production of agricultural crops.

EARLY USES.

The first general use to which this cedar was put was for fences, houses, and farm buildings. Many of the earliest houses in New Jersey, and some in eastern Pennsylvania, were constructed almost wholly of this wood. In making rails of it, farmers preferred trees which would split two, three, or four rails to the cut. The bark was removed, and the rails sometimes gave service extending over half a century. The cost of such rails in the middle of the eighteenth century was from $6 to $8 a hundred. Log houses and barns, and other buildings of the farm, were made of this cedar while it was abundant, but such extravagant use had become infrequent in 1750, and logs had given way to sawed lumber for building purposes. For a long time after that many houses were built wholly or in part of this wood, even as far south as North Carolina. It was taken, on account of its durability, for floors, doors, frames, joists, rafters, but especially for shingles. These were made from 24 to 27 inches long, and while prices varied greatly in different localities, quotations from Baltimore, where they were known as juniper shingles, about 1800, were $4 and $5 per thousand. In 1750 the architects of Philadelphia were criticized because the houses in that city had been designed for white cedar roofs exclusively, and the walls were too slight to sustain roofs of heavier material when a new covering should become necessary and white cedar could not be obtained. Philadelphia was not alone in its preference for roofs of this light wood. Large shipments of cedar shingles went from New Jersey to New York even before 1750, and from that time on all the towns and cities within the range of this timber drew shipments of shingles as well. Some foreign markets had to be supplied also, for at the time when complaint was heard that the white cedar forests were failing daily cargoes of the shingles were going to the West Indies, which also took considerable quantities of white cedar pipe staves.

Southern white cedar was one of the first, if not the first, of American woods used in the construction of pipe organs. A German organ builder, Gottleib Mittelberger, who has been previously quoted, observed when he reached Philadelphia that the patter of rain on the white cedar roofs made sounds highly musical to his ear, "like a roof of copper or brass," and he tried the wood for pipes in his organ work. He declared that the tones emitted by the cedar pipes were finer than from metal. The wood received high praise at an early date as sounding boards in pianos, but it does not seem to have held its ground in competition with spruce.

Next after fences, building material, and shingles, the most important early use of southern white cedar was in cooperage. In some ways it was more important than the others, though the quantity of wood used must have been much smaller. In the vicinity of Philadelphia a special class of tradesmen grew up, known as "cedar coopers," because they wrought this wood exclusively and supplied an extensive and exclusive trade with their wares. Oil merchants were prejudiced in favor of tanks of white cedar for whale oil, and for other oils also, and bought liberally. But the chief trade was in churns, pails, firkins, keelers, piggins, and washtubs. The popularity of that class of wares was due, first, to their excellent quality, but largely to their fine appearance. Wear and use made them smooth and white, and it was supposed that they were more easily kept clean. Another thing which increased their popularity was the common belief that the wood possessed medicinal properties and imparted them to the contents of the vessel. It was even believed that water issuing from a white cedar spigot had its healthfulness increased.

The hoops for the cedar ware were of the same material and were made from saplings from the smallest size up to 2 inches in diameter and 12 feet long. Coopers paid from $5 to $12 a thousand for them. The sale for the special line of wares extended in a limited degree to foreign countries.

MANUFACTURE AND PRODUCTS.

Nearly all the early uses of white cedar have continued till the present, but with much change in the proportionate quantities employed for the various purposes. Fewer fence rails and smaller amounts of rough construction lumber are in use now than formerly, but new uses take more. Telephone and telegraph poles are a modern demand that is heavy. Paving blocks have drawn from this source to a moderate extent. Railroads use rather largely of this wood for posts in fencing their tracks, and they use heavy logs for culvert work. A demand has to be met for piling for wharfs, trestles, bridges, and causeways. Southern white cedar ties go into tracks in large numbers, though some that are listed as this species are really the northern white cedar from the Lake States. It lasts well so far

as decay is concerned, but does not wear well because too soft. Its place is chiefly in trolley roads, where traffic is light, and there it gives good service. Farmers use large numbers of fence posts of this wood, and vineyardists employ it for stakes.

In the building of canoes, skiffs, and small boats, lightness is often a chief requisite, and white cedar is an ideal wood. It answers well as interior finish for yachts and launches; and for similar reasons it is employed by carpenters as house finish. Its light and cheerful color gives a cool, airy appearance to halls and stairways in summer cottages, and by some it is preferred to white pine. It is given place in more pretentious architecture for porch posts and piazza columns. It is made into wedges by makers of furniture and cabinets, and it gives good service in tennis rackets.

Cigar-box makers use white cedar, and some of it goes to the toymaker's shop and to the novelty factory.

BY-PRODUCTS.

A not inconsiderable part of the fighting by which the Revolutionary War was brought to a successful close was done with gunpowder made of white-cedar charcoal. The best results in burning charcoal for that use is had with limbs and sticks not exceeding $1\frac{1}{2}$ inches in diameter.

Lampblack of excellent quality is made of it, and was so made a century ago. The article, when manufactured from seasoned wood, is lighter in weight and deeper in color than the lampblack made from pine.

This cedar has a strong aromatic odor which remains as long as the wood is kept free from moisture, but it largely disappears from wet wood. It does not entirely vanish, however, if the testimony of the men who dig the logs from the New Jersey swamps may be taken. They claim to be able to determine from the odor of a chip cut from a submerged log whether the tree seasoned in the air, or was submerged in its green state, and whether the log will be worth digging out.

Living white cedar trees exude a gum from wounds in the wood, but the quantity is small and its commercial value doubtful.

NORTHERN WHITE CEDAR.

(*Thuja occidentalis.*)

PHYSICAL PROPERTIES.

Weight of dry wood.—19.7 pounds per cubic foot. (Sargent.)
Specific gravity.—0.32. (Sargent.)
Ash.—0.37 per cent of dry weight of wood. (Sargent.)
Fuel value.—42 per cent that of white oak. (Sargent.)

Breaking strength (modulus of rupture).—7,200 pounds per square inch, or 45 per cent that of longleaf pine. (Sargent.)

Factor of stiffness (modulus of elasticity).—750,000 pounds per square inch, or 35 per cent that of longleaf pine. (Sargent.)

Character and qualities.—Very light, soft, comparatively weak, brittle; grain fine, even, and straight; compact, annual rings, narrow; summerwood very thin, dark colored; medullary rays numerous, indistinct; color light brown, turning darker with exposure, the thin sapwood nearly white; easily worked; sapwood not very durable, but heartwood of remarkable durability.

Growth.—Height 50 to 80 feet, diameter 2 to 4 feet.

SUPPLY.

The chief supply of northern white cedar comes from the Lake States, though a little is cut in perhaps a dozen other States. As with southern white cedar, it is impossible to determine how much of the total cedar cut is of this species. In some instances, however, the locality will help to determine. The equivalent of 20,000,000 feet of cedar lumber, lath, and shingles was cut in the Lake States in 1907, and the principal part of it was of this species. In addition to this there were cut in the same region 13,000,000 posts from 7 to 16 feet long, and more than 3,000,000 poles 18 feet or more in length. Estimates of the quantity of northern white cedar yet available in the region have not been made, but it is not believed that anything like complete exhaustion of the supply is near. In addition to posts, poles, lumber, and shingles, this wood supplies many railway crossties. It is too soft to stand excessive traffic, and ties to give long service beneath heavy trains must be protected by plates. They answer the needs of street railways well.

The supply for the future, as far as it can now be foreseen, will come from natural reproduction in swamps and in rugged regions, and not from planting. The tree thrives in situations where many other trees can not maintain themselves. It is at home in the northern swamps, while among the mountains it accepts a foothold on rocky slopes, steep banks, and along the summits and against the faces of cliffs.

USES.

The Indians in the north country sometimes made frames of this cedar for their bark canoes. The wood was lighter than any other that the Indians could put to that use, and that was doubtless a factor in its favor. A few pounds saved in the frame of a canoe meant much to those who expected to carry the vessel across portages and

frequently long distances through forests. The facility with which the wood might be split along the rings of annual growth appealed to the native canoe makers, whose wood-working tools were few and crude. The wood is still used by makers of small boats.

Northern white cedar logs were sometimes, though perhaps not frequently, used in house building. Trees of this species that grow in swamps, and those on river banks and precipices, nearly always have curved trunks which rise from the ground in the form of arcs or ellipses. For that reason they can not be conveniently fitted in house walls. Where better could not be had, however, this tree was pressed into service; and it is recorded of a mission house of this wood at Lake Chicoutome that it was erected in 1728, and in 1792 the logs were sound.[1]

This wood is not often used by carpenters, partly because it is not commonly sawed into lumber, and for the further reason that the softness of the wood renders it incapable of holding nails in positions subject to strain. It is admirably suited, however, for certain kinds of cooperage, where lightness is desirable, resistance to decay a factor, and great strength not essential. It finds such a use for buckets, tubs, pails, and various kinds of small wares. It is important also as a tank material, and for that purpose not the least of its good qualities is its long resistance to decay. Its use has been reported for cigar boxes and in the manufacture of store fixtures.

The northern white cedar is preeminently a fence material in the regions where it abounds, and it is employed for fences of various kinds, some of stakes and small branches crossed and interwoven, others of poles and rails, and still others of posts and boards. Upward of 300,000 posts of this wood were reported to have been used in Iowa in 1908. Used as a fence post, it lasts from 10 to 40 years. The average life in Iowa is reported to be 12 years. In all situations it ranks among the durable post timbers. An instance is recorded of a log that had lain on the ground 130 years and was still sound enough for shingles.

This wood has been extensively used for paving blocks, which in many instances were not given preservative treatment to lessen decay. In 1910 untreated blocks were taken up at Evanston, Ill., after 14 years of service, and though decay was far advanced, the wood was worth something as fuel, and much of it was so used. In 1897 Chicago had 765 miles of untreated block pavement of this wood, and continued to put it down until 1903. It was gradually replaced by other materials, and on December 31, 1909, there remained in the city only 396.9 miles of the pavement. Replacement with other pavement was then going on at the rate of 50 miles a year. In most instances deterioration was due more to the method of laying than to

[1] Michaux's Sylva.

decay or wear. Pavement of this wood was nearly always made of round blocks about 6 inches high, cut from trees from 5 to 10 inches in diameter. Many cities and towns in the Lake States and adjacent regions, both in Canada and the United States, put down large quantities of this pavement from 20 to 25 years ago.

Much bored and banded pipe for water mains was formerly made of this wood, and some is still made.

The early settlers of eastern Pennsylvania and New Jersey made a rheumatism ointment by bruising the leaves of the tree and molding them with lard. Modern pharmacists distill an oil from twigs and wood and make a tincture of the leaves, which they use in the manufacture of pulmonary and other medicines.

Brooms are made of the small and pliant branches of the cedar, and when used to sweep floors they leave a pleasant and characteristic odor. There is considerable demand for such brooms in bungalows and summer resorts in the Lake States region, where the wood may be easily procured.

Red Cedar.

(*Juniperus virginiana.*)

PHYSICAL PROPERTIES.

Dry weight of wood.—30.7 pounds per cubic foot. (Sargent.)

Specific gravity.—0.49. (Sargent.)

Ash.—0.13 per cent of dry weight of wood. (Sargent.)

Fuel value.—66 per cent that of white oak. (Sargent.)

Breaking strength (modulus of rupture).—10,400 pounds per square inch, or 65 per cent that of longleaf pine. (Sargent.)

Factor of stiffness (modulus of elasticity).—940,000 pounds per square inch, or 44 per cent that of longleaf pine. (Sargent.)

Character and qualities.—Medium light, soft, not strong, brittle; grain fine, even, and straight, except as interfered with by knots; annual rings narrow to medium wide, compact; summerwood narrow and indistinct; medullary rays numerous, very obscure; color dull or sometimes bright red, the thin sapwood nearly white, heart and sap sometimes intermingled; easily worked as a result of softness and evenness of texture; heartwood considered as durable as any other American wood.

Growth.—In some parts of its range the red cedar attains a height of 80 to 90 feet and an extreme diameter of 4 feet, but in most regions where it is found it does not often exceed half of that size.

SUPPLY.

The commercial range of red cedar is difficult to define. Its botanical range is very wide, and wherever it grows it is put to some use. At present the chief supply in the market comes from the region

between the Ohio River and the Gulf of Mexico. It is found from Maine to Minnesota and southwest to Texas, and south and east of those lines.

Southern red juniper (*Juniperus barbadensis*) so closely resembles red cedar that the two were long considered identical. It grows in South Carolina, Georgia, Florida, and the Gulf region westward. Its uses are and have always been similar to those of red cedar.

Red cedar was never abundant in the same degree as white pine, yellow pine, or white oak. Numerous other woods probably once surpassed it in quantity; yet a great deal of it was found when early settlements began on the Atlantic coast and pushed inland to the Mississippi Valley. How many feet of it there were at first can not be estimated. The best of it was gone before it occurred to anyone to make estimates and express figures in feet. One hundred and sixty years ago Peter Kalm and Benjamin Franklin, basing their predictions on independent investigations, announced that red cedar could not long continue to meet demands upon it. But these predictions took account only of the cedar of New Jersey, Pennsylvania, and New York. The extensive forests of the South Atlantic States, and particularly those west of the Allegheny Mountains in Kentucky and Tennessee, where the finest red cedar grew, were little known at that time. New Jersey was then supplying, and for many years had supplied, the bulk of the red cedar used at home and abroad. The total quantity before cutting began could certainly have been measured only by hundreds of millions of feet, but a closer approximation can not now be made. Anything like a careful estimate for a large region of standing timber was not made until recently, when figures were compiled for Kentucky. The total stand of cedar there, practically all of it red cedar, was placed at 29,534,000 feet.

The best was culled and cut years ago. As supplies ran short in districts convenient to market, lumbermen pushed farther back in search for more. As late as 1900 from 2,000,000 to 3,000,000 feet of good cedar was rafted down the Cumberland River from the vicinity of Lebanon, Tenn. It is not believed that another such lot will ever be, or can ever be, collected in any locality. Every cedar region has been explored, and choice trees are few. Tracts cut over once or twice before are frequently logged again, and wood is taken which was rejected previously. The search for cedar is even more industriously prosecuted than is the search for black walnut. Comparatively large quantities are still collected, but the grade is lower, because choice logs in large numbers no longer exist. It is not unusual to haul logs 20 miles on wagons over rough mountain roads to deliver them at a railroad station or on the bank of a navigable stream. Such long and expensive hauls are made chiefly to procure pencil wood.

The red cedar, considered as a species, is remarkably tenacious of life. It is hard to exterminate. It has been called a "vagabond tree," because of its habit of living in almost any and all sorts of places—in old fields, along fence rows, in stone heaps, among swamps, in poor soil and fertile, in upland and valley. Red cedar is one of the most common trees found on old abandoned fields from New England to the Southern States. Its roots draw sustenance from soil 6 inches deep, spread over solid rock. The fact that few other trees can do this gives red cedar a sort of monopoly of such situations. The best wood is not produced under circumstances so unfavorable, but all cedar that attains size for poles and posts is good for something; and all kinds of places contribute to the total supply. The better the soil the better the quality of wood.

The red cedar's habit of early seed bearing also aids in keeping up the supply; for as soon as a tree attains an age of 10 or 12 years it bears berries. These ripen the second year, and birds, or chance, or running water distribute them. The seeds of many soft woods are winged, and travel on the wind; but red cedar is less fortunate. Yet, its seeds find lodgment in all sorts of favorable and unfavorable places, and when they once take root, the soil and circumstances must be exceedingly unfavorable if a post, pole, or saw log does not finally result. The tree's worst enemy is fire. The thin bark is easily burned through, bringing death; or the roots, which nearly always lie near the surface of the ground, are scorched, with fatal result. Few young cedars survive a brisk forest fire.

In 1749 Benjamin Franklin published in "Poor Richard's Almanack" an essay on the uses, planting, and management of red cedar in eastern Pennsylvania and in New Jersey. At that time little was known of the cedar resources of the South and Southwest. It does not appear that Franklin's advice to plant red cedar was extensively acted upon. In part he said:

By a diligent observation in our provinces, and several adjacent, I apprehend that timber will soon be very much destroyed, occasioned in part by the necessity that our farmers have to clear the greatest part of their land for tillage and pasture, and partly for fuel and fencing. The greatest quantity of our timber for fencing is oak, which is long in growing to maturity, and at best is of short duration; therefore, I believe it would be to our advantage to endeavor to raise some other kind of timber that will grow faster or come sooner to maturity and continue longer before it decays.

The red cedar (a species of juniper) I take to be the most profitable tree for fencing and several other uses that we can raise in our country, considering how easily it may be raised from seed, its readiness to grow on most kinds of soil, its quick growth, the profits it will afford while it is arriving at maturity, and the long duration of the wood when grown to a proper size for the materials we want for our several occasions in husbandry and building. I know of no other tree that will grow so well on such different soils as this will, for upon

our sandy beaches, which are nothing but beds of sand, they grow as thick as possible, from whence many thousand posts for fencing are brought into Pennsylvania and York governments; and I have seen, in a great miry swamp upon a branch of Susquehannah, great trees growing, near 18 inches diameter, 70 feet high, and very straight. And the inhabitants near the mountains, up Hudson River, make great use of them for making large hovels or barracks to put their corn in before it is thrashed. They will grow well in high gravelly or clay soil, in rich or poor, or even upon a rock, if there be but half a foot of land or earth upon it. It is much to be valued for its quick growth from seed, the little sap, and its much durable heart, which it acquireth sooner than any tree that we can raise on common land. Indeed, the mulberry and locust are of quick growth in very rich land, but not upon poor. A cedar tree, from the berry, will in 8 years be fit for hoops, in 10 for bean poles, in 12 for hop poles, in 16 or 18 for ladders, and in 20 will be big enough to make three posts, besides a good stake at top; with this care, that they are not removed, bruised, or broken, which very much retards their growth, makes them deformed, and spoils their straight, pyramidal growth, which form this tree naturally inclines to grow in more than most trees, and in which we must enjoy the greatest profit from it. And we may in this assist nature by art in carefully trimming them every three or four years, cutting the branches close and smooth off to the bole, so that these wounds may soon be closed, which will make the tree smooth on the surface and the grain straight, which will be of great service if we make boards or rails of them, which will be much the better for being clear of knots. But if we let this tree grow without trimming, as it naturally shoots out branches on all sides in all the degrees of its growth, the lower ones die, but do not rot off near the boles, as in other trees, so that the sap can't close over them, but grows round, which makes the grain crooked, and instead of being straight and even it appears as if drove full of spikes, as we may observe by the posts (especially the second cut) that are brought from the seacoast, where they grow naturally, though not so large or tall as these beyond our northern mountains. It is now generally used for posts, which, as I am informed, will last 50 years or longer, so that one set of these posts about a plantation would last a mature age, which would be a great advantage to farmers, and at the first cost, with white cedar or chestnut rails, would be no dearer than a quick-set hedge and ditch, which must be often repaired. This wood would be of extraordinary service in building, for sills, and for door and window cases, and boards for floors—I suppose one of the best woods, as not being subject to swell with moisture or shrink with dryness, whether or not it would be very good to make large cisterns for the malters to steep barley in and for the brewers for coolers. I have seen sloops a building at Albany of this wood; indeed, the bottom, as I remember, was made of oak, for as the river there is shallow, and the vessels often strike upon sand or gravel, which oak, as being a stronger wood, is better able to bear such a shock than cedar, which is more tender, yet notwithstanding the Burmudians build fine, durable vessels thereof; and I have seen cedar trees growing in Pennsylvania large enough to make wider planks than any I have seen in a Burmuda-built vessel. I believe it would make curious lasting boats, which would swim light, row well, and want but little repairs for many years. I don't doubt but that my countrymen will think, if not say, What signifies telling us of such great advantages which we can't obtain? We don't know how to get either hoop or bean poles of cedar, much less trees for house or ship building. But I am of opinion that with care, ingenuity, and industry we may make the very raising of them to a proper magnitude (exclusive of the value of them when cut down) to be easy, ornamental, and profitable.

EARLY USES.

A smaller quantity of red cedar has been used for fuel than of any other abundant tree in an extensive region. One of the earliest observations by New England writers was the fact that Indians never burned this wood in their camp fires. It burns slowly and with little blaze. It answered very well, however, for charcoal, and was put to some use for that purpose.

The usual form and manner of growth of red cedar lessen its use for lumber. It is occasionally sawed into boards, and always has been, but a red cedar saw log is apt to be an unprofitable stick from the millman's viewpoint. Many trunks are disfigured with longitudinal ridges and deep clefts between them. Thick slabs must be cut off before such logs can be squared, and the waste is large. This peculiarity has always had much to do with lessening the use of red cedar as saw timber, although instances are not wanting where very large and perfect timbers have been cut. The ridges are supposed to result from large limbs, living or dead. The limbs persist long after they become dead and dry, and after the period when most trees would shed them. The result is very knotty lumber. Red cedar justly has the reputation of being among the knottiest woods that go to the lumber yard. When used in round sticks for posts, poles, piles, and stakes, the knots are not a serious defect. Benjamin Franklin suggested in 1749, and Michaux seconded the suggestion 60 years later, that owners of red cedar prune the young and growing trees two-thirds of the way up the bole to lessen the knots when the trees reached saw-log size.

Red cedar was early an important fence material in all regions where it was plentiful. In the South it was often split into rails, and thousands of acres were inclosed with it. North of Maryland mention of red-cedar fence rails is seldom found in early writings, but posts of that wood were very common. In some instances posts of red cedar were mortised for the insertion of white cedar rails, or boards, or rails of chestnut or oak. It was the enormous number of posts employed by Pennsylvania and New Jersey farmers which called from Peter Kalm, in 1750, the prediction that red-cedar forests would cease to exist in 50 years. In Virginia, and probably elsewhere in the South, a kind of hedge fence was made of cedar, which was planted in rows, with the side branches kept clean cut. The remaining limbs were interwoven, and strengthened with stakes when necessary, and a strong living fence was made. Fences of cedar pickets were likewise common, and the wood's resistance to decay gave such fences a long period of usefulness.

In all parts of the red cedar's range it was early put to use in building houses, barns, corncribs, mills, and other kinds of rural structures.

This use was more common in the South than in the North, and was greatest in Tennessee, by some regarded as the region where red cedar reaches its highest development. It has been said that half of the pioneer cabins in Tennessee were of this wood; but the high estimate probably applies only to particular localities. It is certain, however, that it was a popular and much-used building wood in that region. Thousands of houses were covered with shingles made of it, and an extreme period of usefulness, covering 80 years, has been claimed for some of the roofs. It was cut for flooring for residences, barns, granaries, and mills. Heavy cedar puncheons forming porch floors have been found clear and sound after the generation of builders had passed away. Rude cabins in remote localities had joists and rafters of solid cedar that would have done credit to Solomon's Temple.

Early millwrights knew the lasting qualities of red cedar, and used it in rural mills, where in many cases it survived the builders. The hewed and sawed planks and beams made frames, penstocks, forebays, trunks, bulkheads, and dams.

A century ago in Philadelphia red cedar barriers on the sidewalks were 8 inches in diameter and 10 or 11 feet long, and cost 80 cents each. Other fairly good timbers could have been had at that time for one-fourth or one-fifth of that price, but the excellent service which red cedar gave caused its employment regardless of cost.

Red-cedar staves were among the earliest American exports to the West Indies. A larger demand upon the wood was made for home use, for few houses within the regions where the tree was abundant were without their cedar wares, consisting of pails, buckets, tubs, tanks, and all kinds of small wares made of staves. Well buckets were frequently of red cedar when almost any other wood was available. They usually wore out before decay rendered them unserviceable. A red cedar bucket with brass hoops that was made in Tennessee in 1767 was exhibited at the St. Louis World's Fair. The wood was still sound and the hoops bright. Sometimes the red heartwood and the white sapwood were used alternately in cooperage, and this pattern is still in use.

Coffins of red cedar were common in the South, and were occasionally seen in other parts of the country. It was not unusual for the boxes in which coffins were placed to be of the same material.

Red-cedar furniture was among the earliest products of the eastern part of the United States. It was seen in Virginia as early as 1650, and in 1714 John Lawson wrote of such furniture in North and South Carolina, and also of the wood's use in house and ship building in the South. He said it was reputed to be comparatively immune from attacks of marine borers. The Indians of the Carolinas frequently roofed their huts with its bark, and the Ohio Indians made purple

dye from its roots. Among the articles for which it was specially recommended were clothes chests and wardrobes. Its chief virtue, like that ascribed by the early Virginians to sassafras wood, was declared to be its odor, which kept away moths and bugs. Before settlements had advanced 50 miles inland from the coast, red-cedar chests were a well-known commodity, and a very old list of cedar furniture refers to "nests or chests, sweet and fine bedsteads, tables, desks, lutes, virginals, and many things else."[1] The use of such chests has continued during nearly 300 years, and the delicate odor of the wood, which made them popular with the early colonists, is their chief recommendation now. It has always been held that this odor will keep moths and other insects at a distance, and thus protect furs and clothing stored in the chests. The modern chest and wardrobe manufacturer is obliged to make use of cedar wood containing many knots, and with much white sapwood along with the red heart; but this is not held to lessen in any way the value of the commodities produced, and many persons consider the chest made of the variegated wood to be more artistic than if of one solid color.

BOAT BUILDING.

Comparatively large quantities of red cedar were employed by ship carpenters and boat builders nearly 200 years ago. Even earlier than that a small amount was hewed into canoes by white men, and the Indians sometimes made dugouts of it. The drain upon the forests began when shipbuilders discovered that red cedar and oak, particularly live oak, formed a combination valuable in naval construction. The cedar was generally considered too weak for the frames and keels of large vessels, although entire ships were sometimes made of a very similar cedar in the Bermuda Islands. The builders of vessels along the Atlantic coast made the keels and lower parts of live oak or white oak and the superstructure of cedar. This made an appropriate distribution of weight, the heaviest in the bottom, where it served as ballast as well as to give strength, and the lightest in the parts above water. Exact statistics of the amount taken for shipbuilding are not available, but it was comparatively large and called for the very finest trees available. The largest demand is assumed to have been for seagoing vessels, yet much was required for river craft on the Hudson, Delaware, and farther south.

Whale fishermen made a comparatively large demand for the very best grade of red cedar for whaleboats. In the days when a large part of the whale fishing of the world was centered in New England and when large fleets sailed yearly from New Bedford and other harbors for every whaling ground in the world the whaleboat was an absolute necessity. That was before the days of the harpoon gun,

[1] M. Theo. Hariot in Hakluyt's Voyages, vol. 3.

when the hunter learned to kill the game with machinery and at long range. It was then a fight to the finish in immediate contact. In the whaler's phrase, it was "wood to black"—that is, the wooden boat was thrust against the whale's black body—and the harpoons and spades were plied by skilled and fearless men. Having made fast to the monster, the next feat was to cut the tendons of the flukes with a broad-pointed harpoon, called a spade, to weaken the whale and prevent his crushing the boat or making a dash to sea against the wind and dragging the boat with him to destruction. In the fierce contact of such a fight everything depended upon the boat's standing the shock of blows. Red cedar is not the strongest wood—it is really one of the weakest and most brittle—but that was what fitted it for that special use. The frame of the boat was made of oak, but the sides and bottom were of cedar, which would break under a sharp blow sooner than split. A stroke from the whale's fluke would knock a hole in the side, but the wood did not splinter. The same blow would split and splinter from end to end a boat of most other woods, and it would fill at once and sink. Not so with the cedar boat. The hole could be plugged instantly with a mat or blanket kept for that purpose, or in an emergency a man's coat would plug it and keep the men afloat and in the fight.

MANUFACTURE AND PRODUCTS.

No time can be stated, even approximately, when the primitive uses of cedar ceased and manufacturing began. In some lines the wood is now used in about the same way that it was used 200 years ago. As previously said, it has never been extensively sawed for lumber, and in that respect it differs from most of the abundant species of this country. Fence posts of red cedar were a commercial commodity in Pennsylvania and New Jersey 160 years ago and in the Carolinas 200 years ago, and at the same time sold at a price not much below their market value at present, $250 a thousand, reckoning money at its present value. From that time till the present red cedar posts have been manufactured by hand and sold to farmers.

Sawmills were cutting and exporting red cedar boards from New Jersey in 1750. Present furniture manufacturers are simply continuing a business almost as old as the settlement of the Atlantic coast by white men. There has been some improvement in methods of manufacture, and scarcity has taught economy in using the high-grade wood; but in durability and appearance modern cedar furniture has little advantage over that a century or two centuries old. The wood is put to many purposes, as bookshelves, cabinets, brackets, table tops, but rarely as bedsteads now. Its enduring properties make it popular for out-of-doors furniture and fixtures, such as rustic seats, bridges, benches, trellises, railings, and summer houses.

Planing mills make interior finish of it, but not in large quantities, because of the scarcity of suitable lumber. It is seen in porch and interior columns, panels, molding, railing, frames, balusters, and stair work. It is listed as coffin and casket material, but the quantity thus used can not be large. It was so used in the South 200 years ago. Its early use as cooperage continues in considerable volume. The list of such articles includes tanks, buckets, keelers, firkins, piggins, tubs, and many kinds of small receptacles for the kitchen and pantry. An important center of that industry was for a long time in Tennessee.

It is of historical interest that red cedar was one of the earliest woods mentioned for cooper's work in the Ohio Valley. In 1762 tubs were made of it on the Muskingum River in Ohio by C. F. Post and John Heckwelder, who had established a missionary station among the Indians in that region.

Very little of this wood is now employed in shipbuilding, but in vessels of smaller size it is common. It is used as trim for yachts and in canoes. Novelty makers find it suited to their needs as receptacles for salt, boxes for buttons, collars, gloves, and toilet and family articles. Red cedar faucets are a staple article in trade, as for the past century and a half. Occasionally water pipes are made of the wood. The maker of cigar boxes draws a considerable part of his supplies from it. It is generally cut in thin veneer and is laid on a backing of tupelo or some other light, substantial wood. For this purpose red cedar is a strong competitor with the Cuban or Spanish cedar. Telegraph and telephone poles constitute a comparatively recent use for this wood, and a considerable one. Several species, commercially known as cedar, are grouped as one in available statistics, and the number drawn from red cedar can not be determined. But they are cut in all parts of this tree's range, and the South in particular is heavily drawn upon. The poles decay slowly and are good for long service. In a few localities complaint is heard that woodpeckers single out red cedar telephone poles for attack, and excavate nests in them, sometimes so weakening them that they snap off in storms. It is thought that the softness of the wood, and possibly its odor, invite the birds. Attempts to drive them away by plugging their nests with stones have usually made matters worse, for the birds industriously apply their bills to the excavation of a new nest beside the stone packing in the old, and the pole is further weakened.

LEAD PENCILS.

Red cedar is the best lead-pencil wood. Pencil manufacturers procured it in the United States 100 years ago, though at that time the wood was so abundant and the demand for pencils so small that the cut for that purpose was almost negligible. The makers of pen-

cils in Germany took measures long ago to provide this wood without the expense, trouble, and uncertainty of importing it, and planted red cedar. The plantings have thrived, but they fall short of furnishing European manufacturers what they need of the wood, and the United States is still called upon to furnish the principal supply.

Though red cedar was one of the earliest trees to claim the attention of foresters in this country, it has not been much planted for commercial purposes, and the natural growth is depended upon to meet the demands. Pencil manufacturers can afford to pay higher prices for good cedar than most other manufacturers, and in consequence the choice wood goes to them. They often buy it by weight, and the price ranges from 30 to 40 cents a cubic foot, or about 1 cent a pound. The annual demand in this country reaches 110,000 tons, which makes 320,000,000 pencils. The cost of the cedar per pencil is about three-fourths of a cent. This is because as much as three-fourths of the pencil wood purchased never actually enters a pencil, but goes to the waste heap, or is worked into some by-product, as carpet paper or packing shavings. It is estimated that 70 per cent of the bulk and 90 per cent of the weight of pencil cedar purchased goes to the waste pile. It is thus apparent that the pencil maker is one of the most exacting manufacturers who work in wood. The wood must be soft, and this causes rejection of cedar growing outside of a certain limited region in the South. The grain must be straight and free from knots, and this excludes all but clear trunks, though cedar boles are not usually clear many feet of their length. Red rot must be rejected, and this often causes loss of a large part of a log. Black specks, due to old dormant buds, lessen the value of the wood, but do not prevent it from going into cheap pencils. The sapwood and some of the heartwood which is not quite up to the standard for pencils frequently goes to the penholder maker; but the demand is small, and much of that class of wood is destroyed because unsalable. In the past the sapwood was frequently got rid of by allowing it to rot. To hasten the process, the logs were buried under water until the sapwood softened, when it was more easily removed. The process improves the heartwood by softening it and making it brittle, qualities appreciated by pencil makers. At present both sapwood and heartwood are used in pencil making.

The search for pencil wood has been widespread and thorough. Formerly new supplies could always be found by going a little farther back, but the time has now come when virgin stands need not be expected. Cedar cruisers have explored all important districts, and first-class timber has nearly all been cut. Old cuttings have been gone over; logs and trees passed by in early years are now taken. Even old stumps are cut, and some first-class wood is thus obtained. The barns and cabins built of cedar logs and planks many years ago

are not escaping the searchers, and the pencil makers buy this wood in large quantities. Fence rails and pickets go the same way. In some cases the pencil men secure old cedar rail fences by constructing in their places modern woven-wire structures.

A wide and vigorous search for substitutes for red cedar pencil wood has been going on for years. Use of a number of woods has been made, but a substitute in all ways satisfactory has not been announced.

BY-PRODUCTS.

The by-products belonging to red cedar are of minor importance, but are of some value. Shavings are employed to drive moths from clothes presses, and a paper made from the waste in lead-pencil factories is placed under carpets in the belief that it protects against insect attacks. It at least serves the same purpose as any other paper in that position. In some parts of the country the pioneers made tea of red cedar chips, which passed as a substitute for the Chinese commodity. Manufacturers of perfumery use a product distilled from the leaves and wood of the tree. An ointment made by boiling the fresh leaves, and also from powdered dry leaves, is reputed a remedy for blistered feet. Red cedar sawdust is sometimes employed by meat packers in smoking meat. Black walnut and mahogany sawdust are used for the same purpose.

WESTERN JUNIPER.

(*Juniperus occidentalis.*)

PHYSICAL PROPERTIES.

Weight of dry wood.—35.9 pounds per cubic foot. (Sargent.)

Specific gravity.—0.57. (Sargent.)

Ash.—0.12 per cent of dry weight of wood. (Sargent.)

Fuel value.—92 per cent that of white oak.

Breaking strength (modulus of rupture).—6,600 pounds per square inch, or 41 per cent that of longleaf pine. (Sargent.)

Factor of stiffness (modulus of elasticity).—1,060,000 pounds per square inch, or 50 per cent that of longleaf pine. (Sargent.)

Character and qualities.—One of the heaviest of the cedars, soft, grain fine and even, compact, brittle, splits easily; annual rings usually narrow, summerwood thin, not conspicuous; medullary rays numerous, very obscure; color, brown tinged with red, the sapwood nearly white; slight aromatic odor; works easily; durable.

Growth.—Height 25 to 45 feet, diameter 2 to 4 feet.

SUPPLY AND USES.

Range, Idaho, eastern Oregon, through Cascades and Sierras to southern California. The supply of western juniper is not large, nor are its uses many, but certain habits of growth and properties of the

wood give it an importance in many parts of its range. It is a good fuel, and being a high-mountain tree, provides it in many places where other fuel is exceedingly scarce. The tree grows in poor, rocky, wind-swept soil, though it responds to more favorable surroundings by more rapid development and better form of trunk and crown. It is seldom or never cut for lumber, in the ordinary meaning of the term, because the trunks are too short for saw logs. Clear boles more than 6 or 8 feet long are unusual. The wood lasts a long time, and makes durable fences. It gives good service as railway ties, and roads building through regions where it abounds cut all within reach. It is of such slow growth that few owners of land think much of second-crop prospects. A trunk diameter of 20 inches would probably not be reached in a century, and it is supposed that the largest specimens are from 500 to 800 years old.[1] The tree's redeeming feature is that it grows where scarcely any other tree can maintain an existence.

The fine grain, handsome color, even texture, and other characteristics of western juniper indicate that it would make good lead-pencil stock. Though the trunks are too short for saw logs, they might be advantageously manufactured into bolts for pencils.

Other Species of Juniper.

A number of other junipers are found in the region between the Plains States and the Pacific coast. None of them rate very high in commercial importance, yet they are of considerable value in certain localities.

The Rocky Mountain juniper (*Juniperus scopulorum*) is one of the most important of the group. It is found over much of the Rocky Mountain and Plateau region and ranges eastward into Nebraska and South Dakota. Its uses are nearly identical with those of the western juniper.

One-seed juniper (*Juniperus monosperma*) is more restricted, and ranges through parts of Colorado, New Mexico, Utah, and Texas, and within its range is extensively used for ranch timber and fuel. So far as known it is not sawed, and is used only locally, but wood for posts and fuel has been hauled by settlers from the foothills to the valleys and plains. This wood and piñon were often the only ones available.

California juniper (*Juniperus californica*) is a small tree, 20 to 35 feet high, in southern California. The wood resembles that of western juniper, and has similar uses. It is likewise a poor-land tree, and thrives on low desert slopes and plains, where it supplies many of the needs of stockmen, miners, and campers. In some localities it is the chief dependence for fuel and fences.

[1] John Muir, in "The Mountains of California," says the tree attains an extreme age of 2,000 years.

Utah juniper (*Juniperus utahensis*) ranges over the desert regions of Utah, Colorado, Nevada, California, and Arizona. It is too small for lumber, its height seldom exceeding 30 feet, but for fuel and fencing and about ranches and stock corrals it is indispensable in some regions and of considerable use in many others. Trees 10 inches in diameter are sometimes 250 years old, showing it to be of exceedingly slow growth.

Alligator juniper (*Juniperus pachyphlœa*) is the prevailing and largest juniper of the mountains of western Texas, and extends its range into Arizona. It has many names, among them juniper, oak-barked cedar, mountain cedar, thick-barked juniper, and checker-barked juniper. It attains a height of 25 to 45 feet, and a trunk diameter sometimes of nearly 4 feet. Its stem is usually too short for lumber, but a good-sized tree will often turn out many fence posts. It is a desert tree and is found in regions where other timber is scarce. Because of this fact it is of importance for fuel and rough ranch timbers.

INCENSE CEDAR.

(*Libocedrus decurrens.*)

PHYSICAL PROPERTIES.

Weight of dry wood.—25 pounds per cubic foot. (Sargent.)

Specific gravity.—0.40. (Sargent.)

Ash.—0.08 per cent of dry weight of wood. (Sargent.) This is a very low per cent of ash and is equaled by few American woods. Douglas fir, however, has the same rating.

Fuel value.—54 per cent of white oak. (Sargent.)

Breaking strength (modulus of rupture).—9,500 pounds per square inch, or 59 per cent that of longleaf pine. (Sargent.)

Factor of stiffness (modulus of elasticity).—1,180,000 pounds per square inch, or 56 per cent that of longleaf pine. (Sargent.)

Character and qualities.—Very light, soft, not strong, brittle, grain fine, straight and even, annular rings narrow; compact, summerwood thin, dark colored, conspicuous; medullary rays numerous, obscure; the sapwood nearly white; easily worked on account of its softness and even texture; very durable in contact with the soil.

Growth.—Height 75 to 125 feet, diameter 3 to 6 feet.

SUPPLY.

Practically all the incense cedar that finds its way into local or general markets is cut in the State of California. The tree's range extends into Oregon and overlaps a little on Nevada, but not much timber is cut in those States. In some parts of California it is abundant, or once was, and in other parts there is none. Much of the

best comes from the western slopes of the Sierra Nevada Mountains, and very good timber is found at elevations of 5,000 or 6,000 feet. The total available quantity is not known further than that it falls much short of sugar pine, western yellow pine, redwood, and perhaps other California species. It does not grow rapidly. A tree 2 feet in diameter may be 200 years old, and a century is not an unusual period for the growth of each successive foot in diameter. The shape of the trunk does not make it ideal for saw logs, because the base is generally much larger than the bole 10 feet above.

USES.

A large part of the incense cedar cut in California has been made into fence posts. The wood is durable and compares favorably with redwood. The post makers usually split the timber after removing the thick sapwood, which is not acceptable as post material. In small trees and those of medium size the waste caused by rejecting the sapwood is very large, sometimes approximating half the tree. Post makers often prefer fire-killed timber or standing trees that have died from any cause and have subsequently passed through fire. The sapwood of such timber is usually consumed by the flames, leaving the heartwood little injured if it was previously sound. The fact that a dead cedar passes through a fire without being wholly consumed is strong evidence, in the eyes of an experienced post maker, that the charred trunk is sound. If it were not sound, it would have burned and fallen.

Approximately one-half of the incense-cedar timber, as it stands in the woods, is defective. A fungus (*Dœdalia vorax*) attacks it with persistent energy and excavates pits throughout the entire length of the trunk. These galleries resemble the work of ants, and not infrequently ants take possession of them, and it is not improbable that they occasionally enlarge the galleries made by the fungus. This disease is called "pin rot," and though it weakens and disfigures the wood it seldom advances so far as totally to destroy its usefulness. When a tree is cut down the fungus ceases its work.

Though posts for the farmers' fences probably constitute as heavy a drain upon the wood as all other demands combined, it has several other important places in local industries. Lath for plastering, and also lath on which to nail shingles, are made of it. Much has been sawed into shingles, which last well. It is a serviceable and fairly handsome furniture wood, and some of it goes for that purpose. Interior finish is in the same class with furniture, and the wood supplies a number of demands in that line. It is listed as a cigar-box material, and in color and texture of wood it very well fulfills conditions in that trade. Incense cedar has recently been tried as a pencil wood,

and apparently has given good results, as large orders for the wood have been placed by the company which made the experiments. In this use it replaces red cedar. It has been put to extensive use in building irrigation, mining, and other flumes. The bark is employed on mountain roads as a covering to prevent excessive wear, to lessen the dust nuisance in the dry season, and to hinder washing in time of hard rains. The wheels of vehicles grind it to shreds, which pack into an elastic cushion that resists wear for a considerable time.

Incense-cedar boards, 16 feet long or less, are occasionally shipped from the Pacific coast to New York, Boston, London, Paris, and Berlin.

PORT ORFORD CEDAR.

(*Chamæcyparis lawsoniana.*)

PHYSICAL PROPERTIES.

Weight of dry wood.—28.8 pounds per cubic foot. (Sargent.)

Specific gravity.—0.46. (Sargent.)

Ash.—0.1 per cent of dry weight of wood. (Sargent.)

Fuel value.—62 per cent that of white oak. (Sargent.)

Breaking strength (modulus of rupture).—12,400 pounds per square inch, or 77 per cent that of longleaf pine. (Sargent.)

Factor of stiffness (modulus of elasticity).—1,750,000 pounds per square inch, or 83 per cent that of longleaf pine. (Sargent.)

Character and qualities.—Light, moderately strong, grain fine and even, compact; annual rings usually narrow, summerwood not conspicuous; medullary rays numerous, very obscure; abounding in odoriferous resin, satiny, susceptible of a beautiful polish; color light yellow or almost white, occasionally reddish, the thin sapwood hardly distinguishable; very easily worked and durable.

Growth.—Height 135 to 175 feet, diameter 3 to 7 feet. Formerly trees much larger were common.

SUPPLY.

This tree is found in southwestern Oregon and northwestern California, scattered over a region of more than 10,000 square miles; but the bulk of commercial timber is grouped in an area of 300 or 400 square miles, chiefly in Oregon.

Compared with many other American timbers, the supply of Port Orford cedar was never large, because its range is local. Within that range, however, a heavy growth once stood, though it has been greatly depleted. Estimates of that stand, based on what remains in certain localities, place it at more than 4,000,000,000 feet. Exceptional acres have yielded 100,000 feet, and over much of the region where it was

at its best, exceeded 20,000 feet per acre. The timber is not yet exhausted, but it is much scarcer than formerly. The whole history of this timber, from its first announced discovery by white men to the present time, is embraced in the memory of living men. It was discovered in 1855 in the region about Coos Bay, Oreg. A few years later a great forest fire swept the region, and the Port Orford cedar suffered severely, much of the finest timber being killed. The naked trunks in many instances stood 40 years, and were sound at the end of that time. Those that fell likewise remained sound a long term of years.

BOAT BUILDING.

One of the earliest uses to which the people of the Pacific coast put this fine timber was boat building. An important, though not large, industry existed at Coos Bay. Ships large enough to successfully engage in the coast trade were built there, chiefly of Port Orford cedar. That they met every reasonable requirement is evident from the fact that after serving 40 years some of them were declared to be still staunch and strong and good for many years more. The large trunks turned out a high per cent of clear planks, free from knots and other defects, and admirably suited to ship construction. The resin or oil in the wood has been credited with preservative properties which hinder decay. This timber has remained a favorite material for boat building, and small lots of it find their way to many factories in all parts of the country and are made use of in the construction of yachts and other small vessels.

MANUFACTURE AND PRODUCTS.

Dead trees are sawed and split into bolts and are bought by match factories. Small sections of solid wood in defective trunks are cut out for matches. Mills in the range of this cedar saw lumber for general construction purposes, and a specialty is made of grades suitable for interior finish. The wood dresses well and presents a handsome appearance. It is sufficiently hard to make it suitable for floors, and that is one of its chief uses. Some of it goes into furniture in local factories, serving for drawers, shelves, and compartments, while cabinetmakers work panels from clear stock. Porch columns, newel posts, balustrades, spindles, and railing are made of it.

The odor of Port Orford cedar is offensive to most insects that infest clothes chests and wardrobes, and it is claimed that furs and woolens are never attacked while stored in boxes or drawers of this wood. Its use in the construction of such commodities is found in the East as well as in the West. It is made into clothes chests, shirtwaist boxes, chests, wardrobes, hat cabinets, nests of boxes, and similar articles. The interiors are left in the natural state of the wood in

order that the odor may freely distill, but the exterior of the articles is finished to match many woods, such as mahogany, golden oak, English oak, weathered Flemish, fumed, forest green, and others.

The manufacturers of broom handles have found this an excellent wood for their line, and not only are local markets supplied, but regular shipments of broom handles are reported for China, Japan, South America, and elsewhere.

YELLOW CEDAR.

(*Chamæcyparis nootkatensis.*)

PHYSICAL PROPERTIES.

Weight of dry wood.—29.8 pounds per cubic foot. (Sargent.)

Specific gravity.—0.48. (Sargent.)

Ash.—0.34 per cent of dry weight of wood. (Sargent.)

Fuel value.—64 per cent that of white oak. (Sargent.)

Breaking strength (modulus of rupture).—11,000 pounds per square inch, or 68 per cent that of longleaf pine. (Sargent.)

Factor of stiffness (modulus of elasticity).—1,460,000 pounds per square inch, or 69 per cent that of longleaf pine. (Sargent.)

Character and qualities.—Rather light, hard, fairly strong, brittle, grain fine, even, and straight, compact, annual rings narrow and indistinct; summerwood thin, not conspicuous; medullary rays thin, numerous, hardly distinguishable; easily worked, satiny, susceptible of a beautiful polish, possessing an agreeable, resinous odor; color bright, light clear yellow, and thin sapwood scarcely distinguishable; durable in contact with the soil.

Growth.—Height 90 to 120 feet, diameter 3 to 6 feet.

SUPPLY AND USES.

Yellow cedar has a geographic range of nearly 1,000 miles along the Pacific coast and the adjacent islands from Oregon to southeastern Alaska. The strip constituting its range is nowhere broad and in most places is very narrow. Estimates of the available supply are too general to be of much value, but it is well understood that the amount is very large. It is said to be the most valuable wood in Alaska, and as a cabinet wood its beauty has been declared by some to be equal to that of any other tree of North America. Its rare color and the fine polish which it takes constitute two of its chief values; but it has others, one of which is its power to resist decay in the most unfavorable situations. Logs lying upon the damp ground have been known to remain sound for half a century.

Statistics do not exist to show the quantity of yellow cedar put on the market yearly. Statistically the wood is not distinguished from

western red cedar, and even the latter is not always distinguished from other so-called cedars. Yellow cedar deserves to stand on its own merits, and doubtless will when its fine qualities become better known. It has been employed in ship and boat building for many years with most satisfactory results. In this use it competes with Port Orford cedar.

The Indians of southern Alaska and British Columbia prefer this wood for canoe paddles, 30 to 40 of which are necessary for their largest canoes.

Yellow cedar has recently come into favor for interior finish, cabinets, shelving, molding, and floors. Pattern makers draw supplies from it, and it competes with white pine. It is excellent for pyrography, the even grain making it one of the best for that purpose and a close competitor with basswood. Novelty makers, who use many woods from many regions, find this one of the best for a number of purposes, and it is being tried at present for shuttles. It is made into furniture and ranks among the choice soft woods for that purpose. Its use for furniture will probably become extensive on account of its hardiness, evenness of texture and color, and its distinctive pleasing appearance. It is taking the place of Spanish and red cedar for cigar boxes, though the use is not yet extensive. In the search for a substitute to take the place of red cedar in lead-pencil making yellow cedar has been favorably mentioned, but it is not considered equal to red cedar, being harder and heavier.

The wood has been exported in considerable quantities to China, where it has been used as a substitute for satinwood.

Western Red Cedar.

(*Thuja plicata.*)

PHYSICAL PROPERTIES.

Weight of dry wood.—23.7 pounds per cubic foot. (Sargent.)

Specific gravity.—0.38. (Sargent.)

Ash.—0.17 per cent dry weight of wood. (Sargent.)

Fuel value.—51 per cent that of white oak. (Sargent.)

Breaking strength (modulus of rupture).—10,500 pounds per square inch, or 65 per cent that of longleaf pine. (Sargent.)

Factor of stiffness (modulus of elasticity).—1,460,000 pounds per square inch, or 69 per cent that of longleaf pine. (Sargent.)

Character and qualities.—Light, soft, not strong, brittle; grain coarse, even, and straight, compact; annual rings rather wide and even; summerwood about half the width of the ring, dark colored, hard, distinct, medullary rays numerous, obscure; color dull brown,

tinged with red, the thin sapwood nearly white; easily worked; durable in positions exposed to decay.

Growth.—Height 100 to 150 feet, exceptional trees 200; diameter 3 to 8, extreme 16 feet.

SUPPLY.

The western red cedar grows in sufficient abundance over an area of 300,000 square miles to make it attractive to lumbermen. This region embraces portions of northern California, Oregon, Washington, Idaho, British Columbia, and Alaska. The principal cut has been reported from Washington, and that State may be considered as the center of supply. The best timber comes from regions of abundant rainfall and mild humid climate. Near the species' southern limit in California it clings to the fog belts. Its extensive range and the fact that it does not usually occur in pure stands of large extent make estimates of the total available supply difficult. It is certain that cutting in late years has been more rapid than growth, but it is not known how long, at the present rate of cutting, the timber will last. It is not believed, however, that the end will arrive in the near future, although the drain upon the forests is very heavy, and has been for years.

Nature made ample provision for the spread of the species. The light seeds are fairly abundant, and having two wings, they are great travelers and search out favorable situations for germination and growth. Forest fires are the tree's worst enemy. The bark is thin, and a brisk blaze, though of only short duration, is usually sufficient to kill mature timber, while small growth seldom escapes. After the fire has passed, if it has burned the humus in the soil sufficiently to lessen its capacity to retain moisture, the seeds of this tree do not readily germinate. For that reason the tree seldom follows fires, as lodgepole pine does in the West and paper birch in the East. Under normal conditions western red cedar is not exacting in its requirements. It grows in dense shade, and lumbermen cut much excellent timber in deep forests; but shade is not essential, and good lumber comes from tracts where other growth is thin and light is abundant.

It is not so essential in the case of western red cedar as with some other timbers that the trees be cut when they reach merchantable size. They will stand a long time after that before deteriorating. Trunks in good condition at the age of 600 or 800 years have been reported, but the majority of fully matured trees are not so old. Claims of ages 1,500 years or more have been made, but have not been fully substantiated. It is well known, however, that trunks that fell in damp woods centuries ago have lain beneath moss and soil

until the present day in a sound condition. Timber of this kind figures to a limited extent in the lumber supply. Logs dug from swamps, or exposed to view when the moss and humus have been burned off, are sometimes manufactured into shingles or lumber. Cases are vouched for in which the ages of trees growing upon buried logs show that the prostrate trunks fell five or six centuries ago, and even more, and though they have lain so great a period they are found fit for merchantable lumber.

EARLY USES.

The Indians made much use of western red cedar before white men became acquainted with the region in which it grew. From it they obtained food, clothing, shelter, means of transportation, and apparatus for fishing and the chase. From the tree trunks the savages made canoes of all sizes, from the small trough that carried two men to the enormous dugouts that transported 50 or more upon long expeditions in war and peace. Before the Indians obtained metal tools from white traders they hollowed their canoes with fire and with their primitive stone and bone implements. Some of their dugouts are of enormous size, hewed from single trunks, and with lines so perfect that civilized men can scarcely suggest improvement.[1] The making of a canoe of moderate size, by the crude means at the Indians' command in the early days, required several months of hard labor with flint adzes that chipped away pieces of wood not much larger than grains of sawdust.

When Lewis and Clark crossed the Rocky Mountains and reached the tributary waters of the Columbia River in the summer of 1805, they saw for the first time the canoes of the Indians made of this wood. Some months later when the explorers found it necessary to abandon their pack animals and trust to the rivers to carry them to the Pacific, they made their canoes of cedar, and the small fleet successfully descended the Columbia and carried the explorers to the ocean. So common was the use of this wood for dugouts that with many persons its only name was canoe cedar.

The Indians nearly always made their totem poles of this wood, because it is soft and they could work it easily with their rude tools.

[1] It is claimed that canoes made by the Alaska and British Columbia Indians were early taken by fur traders to Boston and New York, where they became the patterns by which the celebrated clipper ships were built. One of the canoes, now in the National Museum, in Washington, is 59 feet long, 8 feet beam, 7 feet 3 inches deep at bow, 5 feet 3 inches at stern, and 3 feet 7 inches in the middle. It was made on Vancouver Island with Indian tools, and is capable of carrying 100 persons with their camp outfits. The canoe is 19 feet longer than the *Sparrow Hawk,* which brought settlers from England to America in 1626. It is said that even larger canoes have been hewed from single trunks of western red cedar. A flare is given the large canoes after the hewing is done, and the width of the beam is increased 8 to 12 inches. The canoe is filled with water which is brought to a boil by dropping in hot stones. When the wood is softened by the heat, the flare is given by inserting braces.

It was valued likewise because it resisted decay a long time, and when the grotesquely carved pole had once been set up in the village or at the cemetery, it could be reasonably expected to stand at least during the lives of those who made it and set it up. Some of these gigantic trunks hewed in forms of men and beasts, often with considerable skill, are the largest pieces of single wood carving in the world, greatly exceeding in size the largest columns and doors of European cathedrals.

The Indians of the region where western red cedar abounded generally chose it for such rude carpentry as they were capable of doing. Their choice was due to the softness of the wood, which meant a great deal to men who hewed and shaped their beams and doors with no better tools than fire, flint, bone, and shell. They made fully as much use of the bark as of the wood. With it they roofed, ceiled, floored, and papered their huts. They wove long strips of bark—sometimes 30 feet in length—into mats, which they used for beds, tables, blankets, and on ceremonial occasions. They made clothing of the same material. They twisted the bark into ropes for dog harness, ladders, fishlines, and snares for wild animals and nets for catching fish. The list of uses for the bark did not end there, for they were able to make food of it. They beat the bark to a pulp, baked it in cakes, and after completely saturating it with salmon oil they pronounced it a palatable and nutritious article of diet. It is believed, however, that the food value of the cakes was derived more from the fish oil than from the bark.

The first white settlers in the region adopted many uses of this wood from the Indian, but the chief was for canoes. What the yellow poplar was as a canoe wood to the early settlers in the East the western red cedar was to the frontiersman and trader in the Pacific region from Alaska southward.

Its value for shingles was early discovered, and as soon as the cabin took the place of the woods camp the shingle roof put in an appearance. The doors and window frames, as well as joists and rafters, were frequently of the same material. The wood's softness had tempted the Indians to use it, and the same property appealed to the white men who succeeded the Indian as the possessor of the country. It was one of the first woods cut for fences, and for many years it was commonly so used wherever it was within reach. It was employed for rails and for posts, and its long resistance to decay is shown by the fact that some of the fences built nearly half a century ago were doing service until very recently.

In the days when cooperage was handwork on the Pacific coast, and tubs and pails were made in each neighborhood, the cedar was one of the choice woods, because convenient, easy to work, handsome in appearance, and serviceable for many years.

MANUFACTURE AND PRODUCTS.

Western red cedar is the greatest shingle wood in the United States at this time, and has held that place for some years, with no likelihood of giving it up in the near future. The average output from this wood alone, and chiefly in the State of Washington, is not far short of 20,000,000 shingles for every day in the year. In 1908 it furnished 63 per cent of the total shingle cut of the United States. Redwood shingles, made only in California, appear with it in the eastern markets, but they form only one-eighth of the cedar output.

This cedar is extensively cut for poles in Washington and Idaho, and large-size poles of this wood are now shipped to nearly all parts of the United States under the name of Idaho cedar. The very long poles seen in city streets are generally of this wood, because other woods do not afford the necessary length. Poles cut from this species taper regularly, and present an attractive appearance when set in line. Their ability to resist decay likewise adds to their value along streets and suburban roads where frequent resetting through cement and asphalt is expensive. Country telephone poles are from 20 to 30 feet long, railway telegraph poles from 25 to 40 feet, and those in cities from 40 to 75 feet.

The wood is used for car siding and roofing, positions where great strength is not required.

More is now used in boat building than in the days of the Indian canoes on western waters, but it serves in a different way. It is now a highly finished product, and is worked by skiff makers and yacht carpenters. It provides handsome trim, lining, railing, and roofs.

It finds more and more demand as interior finish for houses, stores, and offices. Pattern makers use it, and it is seen in window and door frames, and in sash and doors, in molding, chair boards, stairways, panels, and porch work. It fulfills the requirements of outside finish as well as inside, and is being cut into bevel-edge siding in large quantities in many western mills. Cabinetmakers use it for many purposes—the backs and sides of drawers, shelves, boxes, and partitions. It is worked into frames and sash for hothouses, as well as sash for ordinary windows.

Its use in cooperage has come down to the present time, and where it was formerly shaped by hand it is now manufactured by machinery into buckets, pails, tubs, tanks, and the whole line of similar articles.

CYPRESSES.

Although seven species commonly known as cypresses grow in the United States, only one, bald cypress (*Taxodium distichum*), is of great commercial importance. *Taxodium imbricarium*, a closely related species, occurs in the same range as bald cypress and is cut and

used with it. The others, a distinct group of trees, are Monterey cypress (*Cupressus macrocarpa*), Gowen cypress (*Cupressus goveniana*), Macnab cypress (*Cupressus macnabiana*), Arizona cypress (*Cupressus arizonica*), and smooth-bark cypress (*Cupressus glabra*). All of these, because of their limited supply, are put to but small and local use.

Bald Cypress.

(*Taxodium distichum.*)

PHYSICAL PROPERTIES.

Dry weight of wood.—27.6 pounds per cubic foot. (Sargent.)

Specific gravity.—0.45. (Sargent.)

Ash.—0.42 per cent of dry weight of wood. (Sargent.)

Fuel value.—61 per cent that of white oak. (Sargent.)

Breaking strength (modulus of rupture).—7,900 pounds per square inch on pieces 4 by 4 by 60 inches, with 12 per cent of moisture. (Forest Service Circular 15.)

Factor of stiffness (modulus of elasticity).—1,290,000 pounds per square inch on pieces 4 by 4 by 60 inches, with 12 per cent of moisture. (Forest Service Circular 15.)

Character and qualities.—Light, soft, not strong, grain rather fine, straight; annual rings narrow; summerwood broad, slightly resinous, conspicuous; medullary rays numerous, very obscure; color light to dark brown, the sapwood nearly white; easily worked; very durable in contact with soil.

Growth.—Height 75 to 140 feet, diameter 3 to 6 feet, in exceptional cases 10 feet.

SUPPLY.

Bald cypress is found in commercial quantities in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Texas, and Virginia.

In 1898 the amount of standing cypress in the United States was estimated to be 27,000,000,000 feet. The cut since that time has exceeded 5,000,000,000 feet, and the new growth has counterbalanced only a small part of this. A hundred years ago Michaux said: "It is highly probable that in less than two centuries the cypress will disappear from the Southern States." He was led to that prediction by observing the slow growth and the scanty reproduction of the species. At that time the cut for lumber was comparatively small, but cypress swamps were frequently cleared for rice fields. Cypress is not now being planted, and perhaps never will be, for the purpose of growing commercial timber. Natural reproduction must be depended upon, and this does not keep pace with the cutting. Few

cypress trees are large enough for lumber at an age of less than two centuries, and many do not reach sufficient size until much older. The present demand requires 750,000,000 feet yearly, with a marked tendency to increase during the past 10 years. Depletion of supply in the immediate future is not likely, but every year sees a smaller quantity to draw upon. Cypress is an expensive timber to cut and log. It grows in swamps covered with water much of the time. It is customary to dig canals in which to tow the logs to the mills, or to construct railroads through the swamps, driving piles on which to rest the ties. The butt cuts of large cypress trees will not float when green, and to overcome that it is customary to girdle the standing trees several months before felling them. This permits them to dry sufficiently to float. Cypress mills operate on a large scale. In 1908 the average cut per mill was 840,000 feet. That was exceeded per mill by those cutting redwood, Douglas fir, and yellow pine, and none other. Mills cutting maple averaged 128,000 feet, spruce 440,000, hemlock, 400,000, white pine 480,000, oak 170,000, and yellow poplar 100,000 feet per year. In 1908 more than half of the cypress lumber was sawed in Louisiana. Florida came next, with about 8 per cent, while small amounts were sawed in 16 other States, including Delaware, Illinois, and Indiana, and most States south of them. The logs sawed into lumber in Indiana, Illinois, and Delaware were probably brought from States farther south.

EARLY USES.

In the parts of the South settled by the Spanish, houses were generally built of cypress. A century ago there were few houses in New Orleans which were not constructed wholly or in part of this wood, and even outside of the Spanish settlements it was extensively used. Cypress shingles were regarded as so much superior to any others that their use became extensive at a very early period. They were easily made by hand, and were very cheap when suitable timber was abundant. They were split with mallet and frow and sometimes shaved with drawknives. The splitting was done parallel with the rings of annual growth, while with white pine and most other shingle timbers the splitting was done perpendicularly to the annual rings. As with many other woods, it is only the heartwood that shows great durability. The sapwood lasts but a few years when subjected to conditions favoring decay. On the other hand, instances have been cited, on what is apparently good authority, showing remarkable periods of use for heart cypress shingles. A roof at Greenwich, Conn., was laid in 1640, and was said to be serving well 250 years afterwards; another in Brooklyn, N. Y., was said to have lasted 228 years; and another at Clifton, Staten Island, had 200 years to its credit when last reported, and was still in use. Many instances

of use exceeding a century are cited to show the wood's lasting qualities. This is not only true when used as roofs, but for other purposes. New Orleans cypress water mains remained sound nearly a century, and a cypress headboard at a grave in South Carolina was so well preserved after 140 years that the letters on it were easily read. Marble and sandstone gravestones often decay and crumble in less time. A still longer period has been claimed for cypress coffins at Charleston, S. C. It is said they were found in fair condition at the time of the earthquake, though they had been in the ground since 1678.

Along the lower Mississippi River many plantations were once fenced with cypress. Some of it was made into rails, while in other cases it was used as posts with boards nailed on. Undoubtedly all of these cases of great durability represent only heartwood, and that from mature swamp-grown trees.

South of the region of the yellow poplar, the best canoe wood in early times was cypress. Dugouts were almost the only kind of canoe made in the region. John Lawson, writing about 1714 upon the resources of North Carolina, gives valuable information upon the cypress canoes' part in the coast and river commerce at that time.[1] Canoes upon the rivers had a capacity of 30 barrels, and were freighted with flour, lumber, and other commodities. Some were sawed down the middle lengthwise and a piece of wood inserted to make them wider, and they then carried 80 to 100 barrels. The cypress canoe as a freight carrier was not confined to the rivers and landlocked arms of the ocean, but it ventured upon the open sea, and carried pork and other products from Albemarle Sound to Chesapeake Bay by way of the ocean passage. An adventurous canoeman made a decked cypress dugout and applied to the customs officer for clearance papers for it to sail for the Barbados, but the officer refused to issue the papers, declaring that the request proved the applicant's insanity. Record exists of a cypress canoe 30 feet long, 5 wide, and with a carrying capacity of 13,000 pounds.

Builders of sailboats and small ships in the South drew liberally upon cypress for planking, decking, masts, and other parts of the vessel.

It was early manufactured into certain kinds of cooperage, and was shipped to the West Indies for use by molasses and sugar manufacturers. Cypress seems to have been one of the most important of the southern export woods very early in the commercial history of that region, though it was later replaced by white pine in some parts of the West Indies trade. A century ago the export of cypress shingles to the West Indies exceeded 100,000,000 a year. They were 22

[1] "History of Carolina"—John Lawson.

or 44 inches long, and from 3 to 6 inches wide. In 1808 the price in the West Indies for the large size was from $8 to $10 a thousand, and at the shipping ports about half that.

Early builders in the South preferred cypress for door and window frames, sash, and panels. Some of the old brick plantation houses are so finished. Cabinetmakers selected it in that region for the inside wood of mahogany furniture. Some of the historic church doors in the South are of this wood.

Cypress knees, which are peculiar and characteristic protuberances rising from the roots to the surface of the water where the trees grow, were once much valued by negroes for beehives. The large knees are hollow and they served rustic apiarists well. The negroes made a salve of the resin obtained from the bark and cones of this tree, and used it as one of their household remedies.

EXTERIOR AND INTERIOR FINISH.

Cypress is put to almost every use as an interior trim for houses. It may be finished in natural color or stained. The wood contains little resin, and thus affords a good surface for paint, which it holds well. It is much used for door frames, window frames, transoms, ceiling, wainscoting, panels, doors, sash, balusters, inside blinds, brackets, newel posts, grilles, mantels, and to some extent for flooring. It is a popular wood for kitchens, where it is subjected to dampness and heat. It shrinks, swells, or warps but little, and is used for drainboards, sinks, kitchen and pantry tables, cupboards, and kitchen cabinets. For the same reason it is used for breadboards and wooden implements about the pantry, ironing boards, and clothes driers.

For the parts of houses exposed to the weather it serves equally well. As siding it practically wears out before it decays. When made into porch and portico columns it retains its shape, holds paint, and has sufficient strength to sustain necessary loads. It is placed as cornice, gutters, outside blinds, pilasters, and railing, and is much used for porch floors and steps.

COOPERAGE.

Cypress can not be substituted for white oak for the most exacting kinds of tight cooperage, but aside from that it enters into practically all kinds. The properties which fit it for such wide use are the freedom of the wood from knots and other defects which might cause leakage; the freedom from stains or other chemicals by which the contents of vessels would be injured; and the long period which the wood may be expected to last. To this might be added handsome appearance, which frequently has much to do with popularizing a wood.

Tanks of cypress are made to contain the following materials: Acids, beer, cider, dyes, kraut, oil, pickles, vinegar, water, wine, and whisky. Some typewriter manufacturers have reported it to be superior to other woods for holding acid solutions for nickel and copper plating. Various kinds of water tanks are made—swimming, thrasher, windmill, sprinkling, and for railroad water stations.

Vats require the same kind of material as tanks, but there are generally distinguishing features in form or use. Cypress is manufactured into brewery vats, vats for creameries, bakeries, dye works, distilleries, and soap and starch factories. Users of cypress for brewery vats believe that its durability for this purpose is at times as much as 50 years.

Barrels, tubs, and small vessels made of staves are more directly related to cooperage, and for the manufacture of such commodities cypress has a wide use. Among vessels of that kind are those for lard, molasses, oil, sugar, wine, butter, candy, oleo, tobacco (tubs), vinegar, apple butter, jelly, fish, washtubs and washing machines for laundries and private families, and many kinds of pails and buckets, keelers, noggins, kits, and piggins. It is used rather extensively for barrels or troughs in which to salt and store meat on farms. It is said that New Orleans contains 90,000 cypress water tanks.

FARM LUMBER.

Much cypress lumber is employed in the construction of silos for storing green feed. The farmer puts the wood to many uses, in all of which it gives good service. Its lasting properties fit it well for curbs, when material is needed that resists decay. Watering troughs for farm stock and feed troughs for sheds and barns are made of it; likewise troughs or flumes for conveying water from wells or springs. Resistance to decay fits it for stable floors and timbers near the ground, as well as for fences, gates, and especially for fence posts and telephone poles. It is one of the best available woods for picket fences, because it shows paint well and holds it for many years, but lasts a long time without it. It has been widely used for this purpose not only in the South, where cypress grows, but in regions remote from its range.

One of the widest uses of cypress is in greenhouse construction. It is preeminently fitted for that trying place, where it is called upon to resist dampness, excessive heat, and all the elements that hasten decay. It is said that no other lumber approaches cypress in the quantity used for green and hot houses. It is manufactured into sash, frames, benches, boxes, and practically all else that the builder needs. It has replaced white pine to a large degree, because it is cheaper and in some ways better.

MISCELLANEOUS USES.

In some southern cities heavy cypress planks are used for street curbing. Agricultural implement and machinery manufacturers make seed boxes of it, wagon makers employ it for beds, and carriage builders work it into panels for fine bodies. Automobile makers put it to similar use. Its slight tendency to warp has caused its employment by builders of incubators. Car shops use it for freight-car siding, piano manufacturers make shipping boxes of it, and it is a material both for coffins and the boxes in which coffins are shipped. Skiffs, steamers, and yachts are occasionally finished in cypress, and many builders of gasoline launches are said to be using cypress exclusively for hull planking. It also makes handsome church pews and benches. Telephone boxes and switchboards of cypress are coming into use, and spools for some purposes are turned from the wood. Apiarists employ it for beehives; fishermen for seine floats; furniture makers for stools, tables, and curtain poles; molders and machinists use it for patterns; merchants for shelving and counter tops; railroads for shims; and carpenters for tool boxes.

Cypress has been substituted for white oak for wine barrels. It is claimed for it that the wood imparts no color or taste to the wine, and that it is sufficiently dense to prevent leakage, and strong enough to stand rough usage. The same property—freedom from taste—is claimed for it by pump makers, who recommend it for that reason.

PECKY CYPRESS.

It has been estimated that one-third of the cypress in the United States is diseased with a fungus popularly known as pecky, peggy, botty, or some similar name. The disease resembles that which affects the incense cedar of the Pacific coast, and, like that, is supposed to be caused by a species of Daedalea. The fungus enters the living tree through broken branches, dead tops, or decaying knots, and excavates holes in the wood from a quarter of an inch to 1 inch wide and often several inches long. These holes are partially filled with brown powder, a deposit or product of the fungus. Though great numbers of such holes exist, and the trunks are perforated by them, the trees are seldom so weakened as to be broken by the wind. When affected trees are felled, the disease quits working on the prostrate trunks.

The effect of the disease is not entirely injurious, since it is believed to act as a preservative upon the wood which remains and to hinder decay. It is a common saying, though perhaps not an entirely true one, that "pecky cypress never rots." The fact seems to be undisputed that it lasts at least as long as unaffected wood. It is not, however, as strong, because of the perforations, nor is it as

handsome. The use of pecky wood is restricted to places where weakness and unattractive appearance are not objectionable. Large numbers of pecky railroad ties are laid yearly, and give good results. Millions of feet of such lumber are built into sidewalks and platforms in southern towns and cities. That the disease has been a long time preying upon cypress timber is apparent from an examination of cypress logs from swamps near New Orleans, dug from alluvial deposits many feet below the present level of the Gulf of Mexico. Some of that prehistoric timber is pecky, though it has been buried during a period which some estimate at no less than 30,000 years.

Immense quantities of pecky cypress are made into fence posts, which are used by railroads of the region to fence their tracks. The diseased wood is employed also for bridge floors, foundation timbers, and for culverts, boxes, walks, benches, and partitions in greenhouses, and for barn and shed lumber.

SEQUOIAS.

But two species of sequoias grow in the United States, the redwood (*Sequoia sempervirens*) and the bigtree (*Sequoia washingtoniana*). Both are confined to the Pacific coast, largely in California.

REDWOOD.

(*Sequoia sempervirens.*)

PHYSICAL PROPERTIES.

Dry weight of wood.—26.2 pounds per cubic foot. (Sargent.)

Specific gravity.—0.42. (Sargent.)

Ash.—0.14 per cent of dry weight of wood. (Sargent.)

Fuel value.—57 per cent that of white oak. (Sargent.)

Breaking strength (modulus of rupture).—8,000 pounds per square inch, on pieces 2 by 2 by 30 inches at moisture per cent of 15.7. (Forest Service.)

Factor of stiffness (modulus of elasticity).—1,140,000 pounds per square inch, on pieces 2 by 2 by 30 inches at moisture per cent of 15.7. (Forest Service.)

Character and qualities.—Light, soft, moderately strong, brittle, grain fine, even, straight, sometimes curly; annual rings wide in the young timber, summerwood thin, dark colored, hard, conspicuous; medullary rays numerous, very obscure; color light to dark red, the thin sapwood nearly white; splits and works easily and polishes well; very durable in contact with the soil.

Growth.—Height 180 to 280 feet, occasionally over 300; diameter 6 to 10 feet, sometimes 15.

SUPPLY.

The redwood belt extends in a strip 500 miles long from southern Oregon to central California. The strip is narrow, ranging in width from 10 to 30 miles. The commercial range has been estimated to cover 3,000 square miles, but the dense logging woods cover a much smaller area than that. The estimates of the merchantable stand vary. In 1880 the Federal census placed it at 25,825,000,000 feet. More than 20 years later, upon fuller information, private estimates doubled that amount, notwithstanding much cutting had been going on for years. The heaviest stand is near the center of the redwood region, in Humboldt County, Cal., though very dense forests exist both north and south of that point. It is not unusual for 50,000 feet to be cut from a single acre, and often three times that. Single trees of enormous contents have been reported, and it is probable that no other timber in this country can show larger yields per acre.

Mature trees attain an age of from 500 to 800 years. The oldest reported was 1,373 years, so that redwood does not attain to the great age of the bigtree of the Sierra Nevada Mountains. Redwood trunks 20 feet in diameter, with heights of 300 feet or more, have been measured, but the average is much under that, ranging between 6 and 10 feet. When a tree passes the age of 500 years it is liable to die at the top.

Redwood is one of the few softwoods that reproduces bountifully from sprouts. Few trees surpass it in that particular, and the vigor of the sprout growth is remarkable. A large portion of the forest is renewed in that way, and the largest trees retain their ability to send up shoots from the stumps.

EARLY USES.

The splendid redwood was inviting to the early settlers of the region, and they put to use as much of it as they needed. The Spaniards cut sparingly, because they wanted little. They were moderate users of lumber, and for their more pretentious buildings preferred adobe or unburned bricks. They found places for a few heavy beams in their churches and mission buildings, but the majority of these structures were in central and southern California outside the redwood belt, and very little redwood found place. The Russian settlers cut considerably more, but their total cuttings were not sufficiently extensive to make an impression upon the hundreds of square miles of that timber near the California and Oregon coasts.[1]

[1] Documentary evidence of the Russians' activity in cutting redwood is not abundant, but numerous sawpits and stumps evidently cut long ago about Fort Ross and Bodega Bay are said to date from the days when the Muscovites in California manufactured redwood lumber with whipsaws.—"Souvenir Humboldt County," California, p. 3.

Settlements of Americans were planted very rapidly after the discovery of gold, and sawmills in the redwood region put in their appearance about 1850. Lumber was cut for houses, barns, fences, and other farm uses, and a small amount of it found its way to the mines, where it was made into sluice boxes, rockers, sheds, and other mining appliances and appurtenances. But the principal mining fields were not near the redwood forests, and the use of the wood by the placer miners was the exception rather than the rule. In some instances boats were made of it, but it was not esteemed for that purpose as highly as Port Orford cedar, which was abundant about Coos Bay in southwestern Oregon. The chief demand for redwood during the early years was as ranch material. The earliest operations by sawmills were south of San Francisco and immediately north of it. It is said that the first cargo of redwood shipped from the Humboldt Bay region was in 1855, though fir and pine were shipped from there earlier. The cargo amounted to 200,000 feet, and went to San Francisco. The earliest operators picked small redwood trees because their primitive mills could not manufacture those of large size. During the Civil War circular saws began to replace the muley saws of the pioneers, and large timber could be handled.

A redwood picket fence at Santa Cruz, Cal., was said to have remained sound 61 years, and in the vicinity of old Russian settlements fence posts are shown in fairly good condition which it is claimed were placed there almost a century ago. That is proof not only of the lasting property of the wood, but also indicates that it was a fence material at an early date. Pioneers put it to use also for poles, grapevine stakes, wharf piles, piers, and supports for bridges, and well curbs. Though the best of the wood resists decay many years on land or in fresh water, it offers little resistance in salt water when attacked by the teredo or other marine borers. The tannin or other acid which the wood contains is credited with rendering it immune from ravages of land insects and fungus, but salt water apparently leaches the substance out in a short time and leaves the wood defenseless. For that reason piles, wharves, cribs, piers, and sea walls built of redwood in early times have not survived in salt water as well as in fresh.

CROSSTIES AND RAILROAD CONSTRUCTION.

In 1902 the Southern Pacific Railroad had in its tracks west of El Paso 12,000,000 redwood ties. That was twice as many as the ties of all other woods combined. Where the traffic is moderate, and where plates are used between the rails and the wood, these ties last 8 to 10 years. If plates are not used the iron rails cut them rapidly. In

most cases a redwood tie wears out before decay renders it useless. Where traffic is light, as on side tracks and switches, the wood gives service two or three times as long as in main lines. Instances have been cited where redwood ties in California were in daily use for 25 or 30 years, but in those cases mechanical wear was small.

The spike-holding properties of redwood are only fair. Softwoods are generally inferior to hardwoods in that respect, and redwood is in the class with average softwoods. The ties are not only extensively used in California and west of the Rocky Mountains, but they are found in considerable numbers in the railroads of Mexico, Peru, Chile, and even in India. One of the chief properties recommending this timber in some foreign countries is its immunity from attack by ants. The coloring substance in the wood is supposed to be the cause of it, and this timber is often, perhaps always, untouched where other timbers may be devoured. The advance in redwood prices in recent years has excluded it from some regions as a tie material.[1]

Railroads employ redwood for many purposes other than ties. It is an excellent culvert timber, because of its resistance to decay. For the same reason it goes into trestles and bridges in positions where strength is not the chief essential. In sheds, warehouses, and buildings of various kinds it is often selected for the foundation material, sills, sleepers, and pieces near the ground. It is used for car roofs, siding, and interiors. The characteristic which fits it specially for these purposes is its small tendency to shrink or swell. This is important in freight-car material, which is liable to pass in a few days from dry summer heat to cold mountain rains or snows, or into fogs, and back again into dry airs. Redwood stands that test in a way highly satisfactory. It holds paint well, which lessens repair bills. Redwood in freight cars has given 20 years of service, a record that will compare well with that of any other wood.

TANKS AND FLUMES.

The industries of the Pacific coast, and in a lesser degree of the whole country, owe much to the good qualities of redwood as a material for tanks, vats, flumes, conduits, and other structures of that class. Railroad water stations in California, Arizona, and Nevada are well equipped with tanks of this wood. They are frequently a part of municipal waterworks. Eureka, Cal., some years ago built a tank 30 feet high, 54 feet in diameter, and with a capacity of about

[1] Twenty years or more ago it was not unusual in central California, near the lines of the Southern Pacific Railroad, to find numerous fields and corrals inclosed by fences with redwood posts which had served as railroad ties until too badly worn for that purpose. When the railroad removed them from the track the vineyardists and stockmen hauled them away, and by splitting them made two posts from a tie and got many years of service from them.

584,000 gallons, and later added another of equal capacity. When redwood is first used for holding or conducting water the fluid is stained by the coloring matter leached from the wood, and the same result is seen when water flows from a new redwood roof. In a short time, however, the water clears and no unpleasant results follow.

The wine makers of California equip their cellars with redwood tanks for storage purposes. For this class of heavy cooperage it is one of the best obtainable materials. The density of the wood is sufficient to prevent leakage; the grain is straight, making it easy to work; it gives long service; and is not liable to be attacked by boring insects which sometimes riddle pine tanks. Tanners' vats of redwood last a long time, and the wood resists the action of tanning solutions. Redwood vats also meet the trying demands in cyanide plants where ores are separated.

Some of the finest, largest, and best-built wooden water pipes and conduits are of redwood. It meets requirements so well and in so many ways that large use of it is made hundreds and even thousands of miles from the source of supply. The staves are fitted and joined so accurately that leakage is little more than from iron, and it is claimed that the wood is so much smoother that a given pipe will carry more water than one of metal. This is particularly true after the two have been some years in use. The wood grows smoother by wear and the iron rougher by corrosion and accretions. Pipes from 8 inches to 9 or 10 feet in diameter are in use, and single pipes have been built 20 miles long. Redwood pipes and flumes of this kind have been constructed as parts of municipal water plants or of manufacturing concerns or mines in all portions of the United States. The staves are generally shipped ready manufactured, though some fitting is done on the ground. The pipes are bound with iron hoops. It is possible to carry such flumes across ravines or trestles, or under the ground, and if necessary they can rise above the level or sink below it like a siphon.

Brewers coat their redwood tanks with shellac on the inside to prevent direct contact with the wood. Such receptacles are widely used, not on the Pacific coast alone, but in Milwaukee, Chicago, Cincinnati, and other eastern and central cities.

Aqueducts and flumes in connection with irrigation canals are frequently of redwood. In that capacity redwood has figured perhaps more largely than any other timber in the development of irrigation in California. It has given much satisfaction in the construction of large outfall sewers, where resistance to decay is of much importance. Redwood water pipes, built of staves and banded with metal hoops, are used in many parts of the country.

Redwood gutters and eave troughs for houses are widely used, not only in California, but in distant regions.

HOUSE CONSTRUCTION.

Redwood has long had the reputation of being one of the slowest woods to burn, and for that reason one of the safest materials for wooden houses. It does not kindle in a blaze quickly, and so absorbent is the wood that it takes in water almost immediately, so that a redwood house on fire may be saved when a pine building in the same situation could not be. It is not denied that redwood houses will burn, but it is asserted that they are less liable to burn than buildings of most other woods.

Many California towns were built largely of redwood. San Francisco, as it existed before the fire, was said to be three-fourths shingled and sided with it. In many of the towns and villages near the redwood belt its lumber exceeds any other in quantity used, and perhaps in some instances it exceeds all others combined. One of the largest demands upon it is for shingles, in some years exceeding 700,000,000. Vessels sailing around the Horn carried them to Boston and New York at a time when white pine was plentiful in the East and was in direct competition with redwood as shingles. A Boston building with a redwood roof was still well protected against the weather after 31 years of use. In 1907, of all the shingles reported by species, those of redwood averaged the lowest in price at the point of manufacture, being a fraction over $2 a thousand. It has been claimed for redwood shingles, as for railroad ties, that they wear out before they rot. In some cases this appears to be true. The roof on the old quarters of Gen. Grant at Fort Humboldt, Eureka, Cal., has been cited as an instance. When first occupied by Gen. Grant in 1853 the roof was doing service, and the shingles remained sound more than 40 years afterwards, and would probably have held their place much longer had not the nails that held them rusted off. Many wêre sent to the World's Fair at Chicago for exhibition. Decay had not marred them, but the weather, assisted by wind-driven sand from the seashore, had worn some of them very thin where directly exposed. Redwood door and window frames in the old fort buildings were remarkably well preserved after nearly half a century of exposure to weather.

A large part of the nearly half billion feet of redwood lumber sawed annually is for house construction, and four-fifths of it finds buyers in California. More than 30,000,000 feet was used in this country outside of California in 1907. The lumber enters into practically every part of the house. Siding takes a large part, and porch columns, cornice, sills, rafters, joists, and studding are in almost universal use within convenient distance of redwood mills, but many persons consider the softness of the wood an objection to its use for

floors. The extensive employment of the wood in many parts of the world is shown by amount and destination of exports. The figures for 1908 show exports as follows: Australia and oriental ports, 23,829,613 feet; South America, 16,875,046; Mexico and Central America, 9,243,091; Europe and Africa, 4,599,215; Hawaii, 4,067,446; total, 58,614,411 feet.

INTERIOR FINISH.

As in house construction, so in interior finish, redwood meets almost every use and requirement. Floors and ceilings are made of it, and wainscoting, panels, moldings, chair boards, brackets, shelves, railing, stair work, spindles, balustrades, and mantels. Formerly such work was often painted, and the grain of the wood was concealed, but the practice is now less common since the natural beauty of the wood is better appreciated. Its colors are rich and varied, and the finisher who understands the art of bringing out their best qualities can please almost any taste. It is a beautiful wood for carving, and is often so employed. The wood of all redwood trees is not of the same color, nor are different parts of the same tree alike. The soil and situation where the tree grows have much to do with it. Shades range from light cherry to deep mahogany. Where the soil is light the wood resembles Spanish cedar. Some grains are so straight that boards may be split 2 inches thick, 12 inches wide, and 10 or 12 feet long.[1] In other cases the texture is so complicated and involved that all semblance to orderly wood is lost. Such wide extremes in grain and color give the carpenter and finisher their opportunity to make combinations to harmonize with nearly any kind of surroundings. Perfect boards of such width and length may be had that panels, shelves, and counter tops of nearly any desired size may be made from a single piece. A panel of that kind has an added value because the wood warps practically not at all, shrinks little, and disfiguration from swelling need not be feared. If it is deemed desirable to darken the natural color of the wood, it can be done with oils. By well-known methods of treatment imitation of rosewood and mahogany may be produced.

The making of redwood doors has been an important business. They are handsome, light, strong, and hold their shape well under changes of climate. Swelling and shrinkage, which give much trouble with doors of various other woods, are reduced to a minimum with redwood.

[1] There are buildings in the redwood districts constructed of split boards, and so evenly is the splitting sometimes done that a rather close examination is necessary to discover that the lumber is not the product of a sawmill. Miles of roads through the redwoods are corduroyed with split planks of this wood.

FURNITURE.

A small quantity of redwood furniture has been on the market since the wood first came into use, but in recent years the demand has greatly increased. Two distinct patterns of this furniture are made—that which is without figure in the wood, but with pieces and panels broad, ample, and in appearance homogeneous, and that made of figured wood. Formerly the grain of redwood was not often considered by furniture makers, but it has been learned that most pleasing designs may be cut from wavy grain, curly stump-wood and roots, and from the large burls. Pieces with abnormal grain are cut of such size that one slice may be sufficient for a table top or for a massive panel in a bedstead or cabinet. Such wood is worked in the same way as figured walnut and mahogany, though perhaps it is not cut as often in veneers. Exquisite redwood veneers, however, are frequently cut for use by the furniture maker or house finisher.

Redwood burls of exquisite figure and 6 or 8 feet across are sometimes obtained. An armchair has been cut in one piece from a burl, and tables and other articles of furniture when made of it may command prices equal to Circassian walnut or the best English oak. Numerous small articles, such as napkin rings, pin trays, collar boxes, match safes, cane crooks, and many others, are made from redwood burls.

A supply of stumps that will scarcely be exhausted during the present generation is found in the regions where this timber has been cut and the land has not been cleared for agriculture. Many of the stumps have figured grain which is valuable in fine furniture making. The redwood furniture on the market includes nearly all kinds and styles, but the leading articles are desks, bookcases, bedsteads, settees, chairs, tables, bureaus, chiffoniers, and cabinets.

MISCELLANEOUS USES.

Redwood shakes have been a merchantable commodity for 60 years in California, and have sometimes been shipped elsewhere. They are usually split from straight, perfect wood and are used for covering buildings and as siding for barns and sheds. In size they are smaller, but in use very similar to the clapboards formerly employed in the Eastern States as roofing for log cabins and other buildings. The split shake is a wasteful product, and its diminishing use is not a matter for regret. In recent years, however, there has been a tendency to saw shakes instead of splitting them. Sawed shakes were not unknown 20 years ago, but they were not much used. Some of the shingle mills have added shake saws and find them profitable. The product can be made from any wood that will make shingles and no

account is taken of cross grain. The waste compared with that resulting when shakes are split is reduced to a minimum.

Redwood has been tested to some extent for paving blocks. After 15 years' service pavement of this wood has been found in fairly good condition. In this, as in many other of its uses, its resistance to decay is among its chief recommendations. It has others, however, for its softness makes it easy under horses' feet and it is nearly noiseless.

Pattern makers draw upon redwood for supplies. It has not the exclusive field even among California woods, sugar pine being a competitor, while in the East it competes with yellow poplar, basswood, and white pine. Some large manufacturers prefer redwood for this purpose, and it seems likely to gain rather than lose as a pattern material in foundries, machine shops, shipyards, and other factories and shops.

It goes to New York and other eastern cities for tobacco boxes. Comparatively few woods meet the exacting requirements insisted upon, which is that they must not impart taste or odor to the tobacco. Formerly sycamore was almost the exclusive wood for these boxes, but others have come in, notably tupelo, and now the California redwood has successfully met the requirements.

Cigar-box makers are not so choice in material as are the manufacturers of boxes for plug tobacco. Appearance has much to do with their choice, and redwood is meeting the Pacific coast's cigar-box makers' demands.

Redwood box lumber competes with sugar pine and other coast softwoods for fruit boxes. Its dark color is sometimes objected to because it increases the difficulty of doing good stenciling. When both redwood and white fir are convenient and available, many fruit packers prefer the latter for boxes.

Musical-instrument makers do not appear to have drawn heavily upon redwood, probably because the manufacture of musical instruments is not a highly developed industry on the Pacific coast. It is listed, however, as a piano wood by Massachusetts manufacturers.

A small quantity of this timber goes to the makers of wagons and carriages and is worked into tops, chiefly light bodies, seats, dashboards, or in panels for business vehicles, such as bread, butcher, and laundry wagons. The liability of the thin boards to split under a blow tends to limit their use, but that there is demand for them is evident from the fact that they are used in shops thousands of miles from the native timber belt.

Coffins of this wood are largely used on the Pacific coast, where they compete with those of the native cedars.

Before slate and composition blackboards for schools had largely taken the place of all other kinds redwood held a sort of monopoly

for extra widths. One piece was enough for an entire board, and splicing and joining were not necessary. It was little trouble to procure planks 4 or 5 feet wide and as long as necessary. This timber has been sawed in planks 10 feet wide.

Shop signs painted on redwood are occasionally seen in England, and the wood is also used for lining cabinets, boxes, compartments, and drawers. Its use has been reported for lead pencils and champagne corks in Germany. The pearl divers of the Society Islands make of three redwood planks boats, with outriggers, which navigate the lagoons and shoals during the diving season.

BY-PRODUCTS.

Tests of paper making from redwood indicate that the enormous waste about the mills and logging operations might be turned to account. The wood is cooked with caustic soda, and the black liquors from the digesters carry away the coloring matter from the pulp, which is then ready for paper making. The article thus made resembles, it is said, the grade known as butcher's paper rather than print stock.

The black liquor from the digesters is concentrated to the consistency of asphalt, then roasted and reduced to gas, similar to natural or coal gas. It may be used for illumination, for operating gas engines, or for fuel. One ton of redwood scrap from the mill is said to yield 500 pounds of pulp and 10,000 cubic feet of gas. This gas, if used in an engine, would probably furnish enough power to run the mill. It was estimated in 1907 that the waste from the redwood mills in the region of Humboldt Bay amounted to 560 tons weekly.

Redwood bark is used in a small way for many purposes—some useful, others merely ornamental. Novelty stores and souvenir stands along routes of travel in the redwood region, as well as in San Francisco and other Pacific coast cities, exhibit many bark commodities for sale, including pincushions, penwipers, table mats, lamp mats, doilies, moisture-proof match safes, seat mats, bathroom mats, and silk-hat brushes. The bark is also used for fishing floats, temporary cork, life-buoy filling, cork jackets, cold-storage insulation, heat insulation, house sheathing, bicycle grips, mattress fillings, cork carpet substitutes, and sound-deadening insulation. In small towns in the redwood region it is not unusual to lay sidewalks of wide pieces of redwood bark. Such walks are dry and moderately lasting.

WASTE.

The enormous size of redwood timber makes its lumbering wasteful. Sometimes very large trees crush so completely when they strike the ground that little saw timber can be saved. The weights of the

very large trees run from 500 to 1,000 tons. Much experience and skill are needed in cutting them down. A mistake of a few yards in the direction in which they are thrown may entail an unnecessary loss of $100 or more. The débris that strews the ground when one of the 300-foot giants falls is "shoulder deep." However, more careful methods prevail than formerly. It is customary to clear a space and prepare a bed for the tree to fall in, and experienced choppers usually are able to lay the trunk where they want it. It is still the custom of loggers to peel the logs and then burn away the bark and other débris to facilitate getting them out. Often the logs are badly burned. The loss from this proceeding is very large, as much of the standing timber within reach of the fire is killed and the humus destroyed.

Many other wastes were once common, and some of them still are, but the tendency is toward better methods. Crooked and defective logs were abandoned, though they might contain thousands of feet of good lumber. Enough small timber was frequently cut for skid roads and in clearing away to stock a sawmill. In floating down rivers to the mills many logs sank and were lost, and others went to the sea.

Other items, enormous in the aggregate, figure in redwood waste and loss. Large logs are often split with powder to make them convenient to handle. This damages some of the best wood. A large percentage of the trees are wind-shaken, and pin rot affects many. The defective wood and often good wood near it have been thrown away. Increasing demand, however, has caused more attention to be shown to the waste heap, and what will make lath, shingles, shakes, and ties is manufactured into those commodities and others of like kind.

BIGTREE.

(*Sequoia washingtoniana.*)

PHYSICAL PROPERTIES.

Dry weight of wood.—18.2 pounds per cubic foot. (Sargent.)

Specific gravity.—0.29. (Sargent.)

Ash.—0.5 per cent of dry weight of wood. (Sargent.)

Fuel value.—38 per cent that of white oak. (Sargent.)

Breaking strength (modulus of rupture).—6,400 pounds per square inch, or 40 per cent that of longleaf pine. (Sargent.)

Factor of stiffness (modulus of elasticity).—650,000 pounds per square inch, or 31 per cent that of longleaf pine. (Sargent.)

Character and qualities.—Very light, soft, weak, brittle, grain coarse, even, and straight; annual rings generally wide but variable in both young and old trees; summerwood thin, dark-colored, con-

spicuous; medullary rays numerous, thin; color bright clear red, turning much darker with exposure, the thin sapwood white; very easily split and worked; remarkably durable in contact with the soil.

Growth.—This is the largest tree in America, the weight of the largest being estimated to exceed 1,000 tons. Mature trees attain heights of from 200 to 350 feet and diameters of more than 25 feet. Including the great swelled bases, specimens have been measured nearly or quite 40 feet in diameter.

SUPPLY.

The bigtree is of sentimental rather than of commercial importance. As far as actual use is concerned, nearly every timber tree in the United States is superior to it. Even the sycamore, buckeye, tamarack, cottonwood, larch, and elm supply more lumber, and dogwood and persimmon are more useful. Though the largest tree in America, the actual quantity of wood which this species is capable of furnishing is small. This is due to the exceedingly restricted area where it grows. It may almost be said that the number of individual trees is known. While this is not strictly true, it is more nearly true of it than of any other well-known tree. The stand is restricted to a few isolated groves on the western face of the Sierra Nevadas in California, lying at altitudes from 5,000 to 8,000 feet. In most instances these groves are separated by deep canyons, suggesting the probability that the sequoias once formed a continuous forest along the face of the mountain, and that glaciers pushing down the canyons cut the forest into many parts. Though the ice subsequently retreated, the big trees were never able to reunite their fragmentary groves. There is unquestionable geological evidence that the range of the species was once widely extended.

Some persons erroneously suppose that the sequoias are all old and that no young trees are coming on. This is incorrect in most cases. Reproduction is vigorous where conditions are favorable, and if future supply is less than the present it will not be due to barrenness of trees now living. Where protected from fire, seedlings spring up, and if given a chance will hold their place. It is not difficult to plant these trees and make them grow, though it is not probable that planted sequoias will ever exert any influence upon the timber supply. No matter how patient the forester may be, he can not wait a thousand years for his trees to come into market.

When the Government was considering the purchase of the north and south Calaveras groves the sequoias within the proposed boundaries were counted, and those of merchantable size were measured. Trees under 3 feet in diameter were classed as unmerchantable, and were counted but not measured. All seedlings that could be found

were counted, and the total number of all sizes was 3,462. There were 862 merchantable trees listed in six classes, as follows:

Trees containing less than 20,000 feet each	353
Trees containing 20,000 to 40,000 feet each	251
Trees containing 40,000 to 60,000 feet each	112
Trees containing 60,000 to 80,000 feet each	49
Trees containing 80,000 to 100,000 feet each	13
Trees containing 100,000 to 120,000 feet each	2

The 20 largest trees contained an average of 81,386 feet each of merchantable lumber. The average for 862 trees was 27,738 each. The largest tree fell a little short of 120,000 feet, and two exceeded 100,000 feet.

AGE AND SIZE.

There is much disagreement concerning the age and size of some of the largest of the big trees. Different figures as to size, where measurements have been recorded, are due in many instances to different methods of measurement. The tree usually has a greatly enlarged trunk near the ground, and the diameter at 2 feet might exceed by several feet a diameter at 8 or 10 feet. Height measurements ought not and do not show such disagreement where they are carefully made and recorded. One of the largest trees was 25 feet in diameter inside the bark at 6 feet from the ground. One of the tallest trees, measured after it fell, was 365 feet. The tree 25 feet in diameter, mentioned above, was 302 feet high. The bark was removed from its trunk to the height of 30 feet and was exhibited in London half a century ago, but was consumed in the fire which destroyed the Crystal Palace at Kensington.

It might be supposed that many records exist showing the age of big trees that have been felled. Such is not the case, but a few accurate and reliable counts of annual rings have been recorded. In one instance a tree 24 feet in diameter was less than 1,300 years old. Another of similar size was 2,200 years old, according to the count made by John Muir. Another count by him of a tree of similar size showed more than 4,000 rings, but they were so intricately involved that he was unable to satisfy himself that he had counted all of them. It is believed that no tree of this species showing more rings has been placed on authentic record. Claims of greater age have been made, but efforts to substantiate the claims by locating the trees and ascertaining by whom and when the rings were counted have not been successful. Size alone does not prove great age, and no rule of estimate based on so many years for so many inches of diameter can be relied upon. The Forest Service has made accurate measurement and record of every ring of growth in a tree more than 24 feet in diameter, and it is shown that during certain periods of years the

tree grew three or four times as rapidly as during other periods. It is further shown that the times of rapid growth and of slow growth were not dependent upon the size or age of the tree, but occurred at different times during the tree's history, suggesting that successive changes in environment produced changes in the rate of growth, and accounting for the fact that while one tree 24 feet in diameter might be 1,300 years old, another of similar size might be 4,000.

OWNERSHIP.

Some of the finest sequoia groves belong to the United States Government, and are being protected against reckless lumbering and fire, thus giving the younger trees a chance to grow. Other groves are privately owned, and in such cases no sentimental regard protects them against the lumberman's ax and saw, and the trees go to the mills on the same terms as other species growing near them. The cut is far in excess of growth, and when the present stand has been felled the end of private groves will be in sight.

MANUFACTURE AND PRODUCTS.

Lumber cut from the big trees has not generally been put to uses commensurate in dignity with the majesty of the forests from which it comes. Perhaps as much of it has been cut for grapevine stakes as for any other one purpose. It might be assumed that the sequoia's wood merits a place as beams, girders, pillars, and king-posts in solemn churches, enormous halls, and cathedrals where gigantic timbers must support ponderous roofs, balconies, and architraves. But the big tree is put to no such use. It is unfit for such purposes, for the trunks are so vast that long logs cut from them can not be hauled to the mills, while the wood is weak and brittle, and no architect would permit it to go where an excessive load would rest upon it. Beams of long-leaf pine or Douglas fir will sustain burdens which would crush a sequoia beam of similar size. In logging big trees it is frequently necessary to split the logs with powder to reduce pieces to sizes which can be handled. Many fragments result, of shape and sizes not suited for lumber. These are worked into stakes for vineyards, and the loss that would otherwise be due to waste is greatly lessened.

Next after vine stakes, probably fence posts require the largest quantity of this wood, which is very durable. The claim has been made for it that it outlasts any other known wood, but similar claims have been put forward for redwood, red cedar, cypress, western red cedar, locust, and other woods, and no one of them has yet established its claim to first place in point of durability. Big-tree trunks, with the heartwood sound, have lain in the forests for

long periods, possibly in some instances for hundreds of years. It is supposed that the coloring matter in the wood has much to do with preserving it from decay. When sawed or split into fence posts it gives long service, and buyers are anxious to procure it for fence material.

Stakes and posts do not take it all, however, nor generally the best of it. It is made into shingles, shakes, siding, frame material, and rough lumber. Some of the best grades are worked into frames for doors and windows, and also into doors, panels, wainscoting, shelves, turned articles, and furniture. Small trees that do not need to be sawed or split are cut for electric-line poles. Though the wood of mature timber is remarkably free from knots, small trunks are knotty, because young trees retain their limbs nearly to the ground. After the lower branches die and fall off, the new wood laid on is clear. Sound lumber gives satisfaction when worked into flumes, conduits, and water pipes.

The wood has been employed by lead-pencil makers, and in that industry it competes with red cedar. Seven carloads of it were shipped to France in 1905–6, and several carloads were sent later.

WASTE.

The great size of the big trees is chiefly responsible for the unusual waste attending their conversion into lumber. The fall of the mature trunks is so violent that instances have been cited where large trees were so completely demolished that not a stick of saw timber could be cut from them. Heavy loss must occur under the most favorable conditions.

Though it is liable to meet partial destruction when it falls, the tree has means of self-defense and protection while standing which place it on an equal footing with any other tree and superior to most others. Were they not well protected from the ordinary and numerous enemies and dangers which beset and attend forest trees they could not survive 3,000 or 4,000 years, as some of them have done. It has been said of these trees that they have only three foes to fear—lightning, the undermining of their roots by water and erosion, and fire. Lightning sometimes strikes them, but since most of the large trees have stood a thousand years or more without having lightning scars to show, it is evident that they are more remarkable for immunity from, than for injury by, that danger. The undermining of their roots and the consequent settling of the massive trunks toward the injured foundation causes an occasional overthrow, but observation leads to the conclusion that most falls are due to the enormous size and weight of the limbs which grow on the sides where light is most abundant, and which gradually cause the trunk to lean in that direction and finally throw it.

Fire has been the big tree's greatest enemy. Scars on old big-tree trunks record fires that burned 17 centuries ago, and at intervals from that time down to the present. Some of the burns on the trunks were 100 years in healing, yet the vitality of the tree is so great and its stored reserve of food and water so large that it recovers from injuries which would prove instantly fatal to most trees. A trunk stripped of all its bark for nearly 100 feet has been known to survive during several following years. There are trees of other species which, if subjected to such abuse, would wither within 24 hours.

The bark of the big tree sometimes attains a thickness of 2 feet. An ordinary forest fire can not burn through it, and it affords ample protection except where much trash has accumulated about the base of the tree. When an entrance to the wood has once been opened each succeeding fire enlarges it, finally causing much damage to the tree and possibly leading to its fall. The thick bark has a commercial value when manufactured into novelties and articles of use and ornament such as pincushions, penwipers, mats, boxes, frames, trays, and many more. It is not customary, however, to save the bark at the mills when the trunks are converted into lumber, and it is added to the many other wastes.

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Issued October 9, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

FOREST SERVICE—BULLETIN 99.

HENRY S. GRAVES, Forester.

USES OF COMMERCIAL WOODS OF THE UNITED STATES:

II. PINES.

BY

WILLIAM L. HALL,

ASSISTANT FORESTER,

AND

HU MAXWELL,

EXPERT.

WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Forest Service,
Washington, D. C., June 10, 1911.

Sir: I have the honor to transmit herewith a manuscript entitled, "Uses of Commercial Woods of the United States: II. Pines," by William L. Hall, Assistant Forester, and Hu Maxwell, Expert, and to recommend its publication as Bulletin 99 of the Forest Service.

Respectfully,

Henry S. Graves,
Forester.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

USES OF COMMERCIAL WOODS OF THE UNITED STATES.

II. PINES.

INTRODUCTION.

Thirty-seven species of pine grow in the United States, no one species in all the States, yet, with perhaps one exception, no State is without one or more. Some, as the loblolly pine of the South, the white pine of the North and East, and the western yellow pine, occupy large regions in considerable abundance, while others, as the Apache pine of the Chiricahua Mountains of Arizona, the Torrey pine along the Soledad River in California, and the sand pine near the Gulf coast of Florida and Mississippi, are so scarce that few persons ever see and recognize them. Yet no species of pine is so scarce that it is not made in some way to serve man's needs.

About 48 per cent of the total lumber output for the United States in 1908 was pine. The longleaf probably furnished more than any other single species, and white pine was next. The western yellow pine, which is more widely distributed than any other pine of this country, is a large producer of lumber, and the western white pine and the loblolly also rank high in quantity. This bulletin considers each species separately. The places which some species occupy are very humble, and they can never rise much in the scale of usefulness, yet each one is entitled to its own individuality.

Four important timber trees of the southeastern United States are usually grouped as one in the lumber market, and are sold under the common name of yellow pine. They are the longleaf pine, shortleaf pine, loblolly pine, and Cuban pine. In appearance the woods of these four trees are so nearly alike that it is sometimes difficult to distinguish one from the other; yet in some particulars there is considerable difference. This is often seen in the growth rings. Longleaf annual rings are usually narrow, shortleaf wide near the heart, followed by a zone of narrower rings, while loblolly's rings are generally very wide. The Cuban pine also has wide rings. The proportion of sapwood to heart is usually different in the four species. Longleaf pine over a foot in diameter, breast high, rarely has sapwood over 2 or 3 inches broad; shortleaf sapwood in trees of like size usually measures 4 inches, while loblolly often runs from

4 to 6 inches. The sapwood of the Cuban pine resembles that of loblolly more than longleaf. In resin contents, longleaf is very abundant, loblolly less so, and shortleaf still less. In this particular Cuban pine ranks close to longleaf. The weight of the wood of the four species varies through rather wide limits, and it would perhaps not be practicable to distinguish them by that test alone.

LONGLEAF PINE (Pinus palustris).

PHYSICAL PROPERTIES.

Weight of dry wood.—43.6 pounds per cubic foot (Sargent).

Specific gravity.—0.70 (Sargent).

Ash.—0.25 per cent dry weight of wood (Sargent).

Fuel value.—94 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—16,100 pounds per square inch (Sargent).

Factor of stiffness (modulus of elasticity).—2,118,000 pounds per square inch (Sargent).

Character and qualities.—Heavy, hard, very strong; tough; grain fine, even, straight; compact, annual rings narrow, especially in young and old growth, summerwood broad, occupying fully half the width of the annual growth, proportion of heartwood large; very resinous, resin passages numerous and large; medullary rays numerous, conspicuous; color light red or brown, the thin sapwood light yellow; durable in contact with the soil.

Growth.—Height, 55 to 100 feet; diameter, 1½ to 3 feet.

SUPPLY.

The commercial range of longleaf pine lies in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Texas. Few woods have a greater number of names in different localities than this tree. Among them are longleaved pine, southern pine, yellow pine, turpentine pine, rosemary pine, brown pine, hard pine, Georgia pine, fat pine, southern yellow pine, southern hard pine, southern heart pine, southern pitch pine, heart pine, pitch pine, longleaved pitch pine, long-straw pine, North Carolina pitch pine, Georgia yellow pine, Georgia heart pine, Florida yellow pine, Florida pine, Florida longleaved pine, Texas yellow pine, Texas longleaved pine.

The total stand of the timber pines of the South is estimated by the Bureau of Corporations at 384 billion feet.[1] Of this amount, 232 billion feet is of longleaf and 152 billion feet of shortleaf and loblolly pine. The figures for the longleaf include whatever there is of Cuban pine, as the two species were not distinguished by the Bureau of Corporations. It has been roughly calculated that, at the present rate of cutting, the supply of the southern pines will last from 20 to 30 years; and since the rate of lumbering is relatively about the same for all regions where the different species grow, it is assumed that

[1] Report of the Commissioner of Corporations on The Lumber Industry, February, 1911.

failure of supply will come to the four species at about the same time. Much more of longleaf and loblolly remain than of shortleaf and Cuban.

Longleaf pine in many sections of the South reproduces itself with vigor, but because of its slow growth while young it fails to establish itself as well as the white pine of New England and the yellow pine of the far West. Fire is the one great enemy over all of its range, and destroys seedlings in vast numbers, though larger trees resist well where they have not been boxed for turpentine. The prospect that new growth will take the place of the forests now going down before the lumbermen is not encouraging, more because of slow growth than of difficulties in reproduction. The annual drain upon southern pine forests to supply the demand for lumber, and the fact that fires interfere so greatly with reproduction, must lessen the remaining supply very rapidly.

EARLY USES.

The early explorers and colonists encountered the longleaf pine practically all the way from the Chesapeake Bay to Texas, with the exception of southern Florida. As the country began to be settled immediate demand upon the forests was made for building material needed in an agricultural region. A hundred years ago it was claimed that 75 per cent of the lumber in residences in the longleaf-pine region was of this wood. In many cases the entire house, so far as it was made of wood, was of this material. The most frequent exception was the roof, where cypress was commonly employed, with occasional roofs of red cedar and southern white cedar. In some cases shingles of pine supplied roof material also. Barns, sheds, stables, and all farm buildings drew enormous supplies from the neighboring longleaf-pine forests, and the inclosing of fields and plantations added to the demand. Pickets for garden and yard fences were sawed from the wood, and post and plank fences were sometimes constructed wholly of it. When pine posts were used it was customary to select the dead timber that had become "fat," a term applied to wood surcharged with resin. It was claimed that sometimes timber left standing after it was dead would double in weight, merely from the accumulation of resin in it; but figures showing an increase in weight so large as that should be accepted with caution. It is certain, however, that the fat pine posts gave long service, which led to extensive use of that class of timber. Rail fences were common in early plantation days in the South, and the longleaf pine was split for rails and lasted well.

One of the earliest demands upon the longleaf pine was for bridge material. Public highways and private roads depended largely, some-

times almost wholly, upon it when streams and ravines were to be crossed.

Long-leaf pine contributed to the machinery used on southern plantations, though in early times the use of farm machinery was more limited than at present. A large part of the work was done by hand labor; but wagons and carts were indispensable, and the beds were oftener made of pine than of any other wood.

The old Ramage printing press, made a century and a half ago and now in the National Museum at Washington, D. C., is largely of longleaf pine.

EXPORTS.

The exportation of building material from the longleaf-pine region began very early, and the lumber for that purpose was sent in small sailing vessels to Cuba and the eastern coast of Mexico and Central America. It was preferred in many cases to the native timber, because it was comparatively free from attack by ants, which in tropical countries frequently destroy houses and eat away bridge timbers.

The southern pines attained to considerable importance in the export trade soon after the Revolution, and at the beginning of the Civil War were going in quantity to English markets. The closing of the southern ports early in the war left some of the operators and contractors with timbers on hand which they had expected to send abroad. A large number of rafts were caught in the Altamaha River by the blockade, and these the owners towed to places of concealment in estuaries and bayous, where they remained unmolested until the war's close.

It was about that time that the longleaf pine began to displace in English shipyards the pine from Memel (a port on the Baltic Sea).[1] It found place in heavy construction on land, as well as in shipbuilding. It was stronger than the Memel pine and could be had in longer pieces, up to 45, 50, and even 60 feet in length, and 14 inches square, free from sap. A favorite use for such timbers in England was for wharves and harbor works, as well as for supports for roofs and galleries in churches and other large buildings. Pavement was made of it for shop floors, each block being made of four pieces fastened together with dowels. The timber in England has given 20 years' service in damp and unfavorable places, but has not proved so satisfactory in South Africa, particularly near the Cape of Good Hope and near rivers, where the climate is alternately dry and damp.

In the export of lumber at the present time from the United States to foreign countries the southern yellow pines are not listed sepa-

[1] Timber, J. R. Baterden, London, 1908.

rately, and it is not practicable to determine what part of the total lumber exports they supply. It is believed, however, that a billion and a half feet of these pines go yearly to foreign countries, the most of it longleaf. This places it above Douglas fir, its next nearest competitor, as an export wood. The pine is sent in large quantities to Mexico, the West Indies, Central America, the Panama Canal Zone, South America, and to Great Britain and the Continent of Europe, as well as to many other parts of the world.

SHIPBUILDING.

From the earliest times the southern shipyards drew supplies from longleaf-pine forests. The timber was sent to northern yards also, and its value for masts was quickly recognized after the southern forests became known. It is heavier than white pine, and to some extent its weight was objectionable, but its other qualities were so much in its favor that it speedily won its way. Before supplies began to be drawn from the South the Riga and Danzig pines from northern Europe furnished masts for a majority of European vessels, but in a few decades after commerce with the South began the longleaf pine had distanced its competitors in that trade. For the largest masts, however, it could not compete with the New England white pine. Spars, yards, and other timbers employed in ship rigging were bountifully supplied by longleaf pine, and large quantities of sawed planks were used.

The first war vessels built by the United States Government, beginning about 1797, used longleaf pine to some extent, though the frames and other parts subjected to shock and strain were of live oak. The six vessels forming the first Federal Navy had the southern pine in them. The *Constitution*, launched at Boston in 1797, and which in its long and eventful history captured 16 ships, still rides at anchor at Boston, but it can scarcely be called the same vessel that won the victories nearlv a century ago, for piece by piece it has been rebuilt until practically all the old wood has been replaced by new. However, the figurehead that ornamented the prow of the ship when it first sailed remains, though it shows the weathering effect of over 100 years of sunshine and storm. It is of longleaf pine—a wood which in this instance has outlasted all that were associated with it in the building of the ship.

Boat builders in all eastern and southern yards of the United States use longleaf pine. It serves in nearly every part of boat frames and planking, in large craft as well as in small.

HEAVY CONSTRUCTION.

Only one other timber in the United States at present stands on an equal footing with longleaf pine in heavy construction, such as

beams, girders, sills, sleepers, joists, trusses, rafters, columns, and heavy floors, and planking. That wood is Douglas fir of the Pacific coast. It has been said that lumber dealers do not always distinguish between longleaf, shortleaf, loblolly, and Cuban pines, but longleaf is the most important of the group. Its strength, stiffness, freedom from defects, and its lasting properties fit it for many places in heavy construction. The demand for pieces of unusual size is met to a large extent by southern mills which cut this species.

RAILROAD TIMBERS.

In 1907 the railroads of the United States purchased 34,215,000 ties of southern pine. In 1908, largely due to the financial depression, the number fell off to 21,530,000, and decreased to 21,385,000 in 1909. It is impossible to tell what proportion was of longleaf, but it is known that it was large. The cutting of ties in the southern pine forests has caused much waste. It has been estimated that not less than 70 feet of lumber are sacrificed to procure one tie, which, at most, contains not above 50 feet, and generally nearer 40. Ties are usually cut from young trees.

Builders of railroad bridges and trestles draw a large part of their heavy timbers from the longleaf forests. The wood is preeminently fitted for that use. It may be had in long pieces, free from serious defects, and possesses great strength and stiffness. In addition to that, it has enduring qualities which add much to its value.

It is extensively employed in car building, to some extent for passenger cars, but chiefly for freight. It is used for siding, lining, roofing, flooring, beams, and frames. The timber's elasticity is its chief value in car building. Sticks free from defects are often demanded 10 inches square and from 36 to 42 feet long. Elasticity adds value to the crosstie also, for the wood must yield under weight and strain and quickly recover its former shape and position.

MANUFACTURE AND PRODUCTS.

Southern pine has always had a place as interior finish in the South, but until comparatively recent years it was not favored for fine work, but was chiefly confined to kitchens, pantries, back stairways, and similar places. It was nearly always finished in natural colors, if finished at all; but when it was discovered that it took stains well it quickly rose to importance and has attained wide use. In the best construction, however, it has never reached a footing equal to oak, chestnut, and birch. Immense quantities are made into flooring, and manufacturers of window and door frames and of sash and doors draw supplies of raw material liberally from that source. It finds place as finish for kitchens, halls, libraries, and

sleeping apartments. It is made into stairs, railing, molding, spindles, balusters, and newel posts. Church and schoolhouse finish is made of it, and it has extensive use in the manufacture of furniture, cabinets, and wardrobes. Various parts of machines are made of it in southern mills, shops, and factories, and the makers of farm machinery and appliances use it in many ways where formerly ash and oak were the only woods employed. In a large part of the country it is so universally used that there are but few places of importance that it does not fill.

Formerly it was customary for large contractors to specify that the timbers supplied should not be "bled," referring to the practice of extracting crude turpentine from living trees. It was supposed that the wood from such timber was inferior. Railroad companies frequently excluded such stock. Tests by the Forest Service some years ago showed that "bled" timber is not reduced in strength. The bleeding does greatly increase the amount of resin in the butt of the tree, and this is sometimes found objectionable. Also, the turpentining of the tree does reduce to some extent the quantity of first-class lumber which can be obtained.

PAVING BLOCKS.

The extensive use of wooden paving blocks, treated with preservatives to retard decay, covers a period of only a few years in this country, and longleaf pine has been the principal wood so used. Before the necessity for wood preservation and the methods of bringing it about were well understood, a large amount of wood pavement was laid in many cities of this country. Of this untreated wood pavement there was probably more northern white cedar from the Lake States than of all other woods combined. The unsatisfactory use which such pavement gave led to its abandonment, and treated woods came in. The hard southern pines, particularly the longleaf pine, were favored by many cities, and in 1909 more than a million square yards of this timber received treatment for use as paving blocks. Some use of it was made long before. Between 1860 and 1870 Brooklyn laid pavement of this wood previously dipped in coal tar. The average life of the blocks under traffic in that city was about 6 years.

Treated paving blocks of the southern pines have replaced other materials to a considerable extent in many American cities and have gained some foothold in European cities. In this country they have been laid in New York, Boston, Baltimore, Washington, Indianapolis, Chicago, Minneapolis, Duluth, and in other cities. In addition, much wooden pavement has been laid between car tracks in cities, on wharves and landings, in coal yards, on bridges, in ware-

houses, foundries, shops, roundhouses, breweries, cellars, bottling works, and in many situations where heavy wear must be sustained and liability to decay resisted.

MISCELLANEOUS.

Longleaf pine is largely employed in railroad water tanks, towers, for windmills, and receptacles for liquids in factories and mills. The tank itself and the stand on which it is placed are frequently of this wood, but in tank building longleaf pine is not as extensively used as cypress.

Trunk makers use many woods in their business, and longleaf pine has a prominent place, though its weight places it at a disadvantage when competing with others.

Excelsior cutters draw upon it for supplies, but it has no superiority for that use over many other woods.

A small quantity of longleaf pine is manufactured into pulp, the material used for the most part being sawmill waste. At certain plants in the South it appears that the process of making paper from sawmill waste is becoming established on a successful basis. If so, it means the extension of the pulp industry to the Southern States, with longleaf pine as the raw material.

The long, clear timbers cut from this pine are well adapted to the manufacture of wooden pumps, and a considerable amount is so used.

Elevator builders draw supplies from the longleaf lumber yards of the South, where clear stock and exceptional lengths may be had.

NAVAL STORES.

Longleaf pine has held an important place in the production of naval stores since the development of the country began. A century ago Michaux listed the longleaf pine's products as "wood turpentine, scrapings, spirits of turpentine, rosin, tar, and pitch." He described turpentine as the raw resin that exuded from the wounds in the trees; scrapings, as the dried substance that adhered to the wounded surface; spirits of turpentine, as the product passing over in distillation of turpentine; rosin, the residuum of distillation; tar, the substance obtained by the destructive distillation of pine wood; and pitch, the product obtained by boiling the tar. Longleaf pine has been and still is nearly the entire source of these products.

Immediately after settlements began on the Atlantic coast Great Britain encouraged the development of the naval-stores industry. Her ships demanded large quantities, and the supply then came from the Baltic Provinces and from Russia. Monopoly, it was claimed, raised the price, and in time of war there was danger that supplies

would be cut off. For that reason it was desirable that America should become a producer of the commodities so necessary to the maintenance of England's position upon the seas. The colonists in New England had scarcely landed before they were encouraged to look into the possibility of developing the naval-stores industry. The same was true in Virginia. Within 15 years after the feeble settlement had planted itself at Jamestown a report was made on the possibilities of developing the tar and pitch industries in the region on and near the coast of Virginia.[1] The report was unfavorable, for the reason, as it was set forth, that pines were too much dispersed to make the manufacture of pitch and tar profitable. This report has been construed as evidence that pine was much scarcer in the original forests of tidewater Virginia than in the secondary forests which grew afterwards.[2] The prevailing pine in that region is loblolly, which readily takes possession of abandoned fields.

The manufacture of naval stores began on a small scale in the longleaf pine region and grew gradually. Statistics showing the progress of the industry are fragmentary. In 1704 the shipments of tar to England from the Carolinas amounted to 400 barrels. One hundred years later the annual output of the South was 77,827 barrels. How much of this was tar and how much was rosin and other products is not shown. The shipments went to Northern States and to Europe. In the North the article was employed to a considerable extent by soap manufacturers. In the same year (1804) 19,526 gallons of spirits of turpentine were shipped from North Carolina. In later years petroleum was substituted for spirits of turpentine in many arts and industries.

The value of the naval stores produced in the United States in 1908, chiefly from longleaf pine, was $21,895,950. Florida was the largest producer. At one time North Carolina stood first, then the first place went to Georgia, and later to Florida. The center of the industry shifted from region to region where pine was most convenient and abundant. In early years the turpentine operators destroyed forests for naval stores alone and made no use of the wood. They boxed the trees—that is, cut deep notches in the base of the trunk—and collected resin year by year for a time. When the trees could produce no longer they were abandoned to fire and storms. The

[1] Neill's Virginia Co. of London, p. 283, report made in 1622.

[2] An inference that pine was plentiful near the sea, but not in the interior, has been drawn from a paragraph in John Oldmaxon's British Empire in America, edited by Hermann Moll, London, 1708. In accounting for the failure of grape culture in Virginia, he said: "Fir and pine trees, with which the country abounds, are noxious to the vine; and the experiments that have been made were in the lowlands, subject to the pine, and near the malignant influence of the salt water." (Vol. 1, p. 306.) Two hundred years ago, and about the same time that Oldmaxon wrote, John Lawson traversed the uplands of North Carolina for a distance of 125 miles and noted particularly that he saw no pine trees, but when he had proceeded eastward into what he called the "lowestmost parts" he encountered an abundance of pine.

weakened trunks were broken and fire completed the ruin. At the present time less wasteful methods are employed. The lumber is valuable and less frequently left to burn or decay. Improved methods have been found for extracting the resin. Cups are taking the place of the deep boxing that once was everywhere in use. Under the new system of working the product is better and more abundant, and the trees sustain less injury. In 1908 about 14 per cent of the turpentine was produced by the cup method. The improved processes continue to grow at a rapid rate.

A considerable portion of the longleaf pine forests of northern Alabama were denuded years ago to supply charcoal for iron furnaces in that region. A similar use of the wood has been made wherever sufficient market has existed for charcoal. In some localities refuse wood only is taken, while the rest goes to the lumber operators.

BY-PRODUCTS.

Several billion feet of yellow pine pass through dry kilns yearly, and it has been estimated that for every 1,000 feet entering the kiln a gallon of turpentine evaporates and is wasted, or an equivalent of 3 or 4 million gallons annually. It is believed that the expulsion of nearly all the turpentine from the wood is practicable, and that little or none of it need be wasted, while the quality of the lumber would be improved. Turpentine and pine oil are now being obtained from longleaf pine mill waste at a number of southern mills by steam distillation. At certain mills the shredded material is afterwards used for manufacturing paper. It is estimated that the waste of longleaf pine is sufficient to supply a quantity of turpentine equal to that now produced in the naval-stores industry. A large number of plants are running on longleaf pine stumps and "fat" logs by the destructive distillation process. The chief products of this process are turpentine, pine oil, pyroligneous acid, charcoal, and tar. In certain extraction processes the turpentine, pine oil, and rosin are obtained. The obtaining of such products from longleaf mill waste appears to be on the threshold of rapid increase.

The long needles of this pine have been used for various purposes. If distilled green, an oil of balsamic odor is obtained, closely resembling spirits of turpentine. By the distillation of the wood spirits of turpentine may be obtained, the yield running from 1 to 10 gallons per cord. Pine wool is made from pine needles by boiling them in a strong solution of alkali. The resulting fiber is cleaned, carded, and made into fabrics or used in upholstering.

One of the materials used in manufacturing lilac perfume is terpineol—made from turpentine. The manufacturers of synthetic camphor employ turpentine in the process. Pine oil has its largest use

at present among the varnish manufacturers, but there is a possibility of its use as a substitute for linseed oil in the manufacture of paints.

SHORTLEAF PINE (Pinus echinata).

PHYSICAL PROPERTIES.

Weight of dry wood.—38 pounds per cubic foot (Sargent).

Specific gravity.—0.61 (Sargent).

Ash.—0.29 per cent of dry weight of wood (Sargent).

Fuel value.—82 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,800 pounds per square inch, or 67 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,948,000 pounds per square inch, or 97 per cent that of longleaf pine (Sargent).

Character and qualities.—Heavy, hard, moderately strong; grain rather fine, even; annual rings generally wide near the heart, followed by zone of narrow rings; summerwood broad, often occupying half the width of the annual growth; resin moderately abundant, especially near base and near knots; resin passages numerous, medullary rays numerous, conspicuous; color, orange or lighter yellow, the sapwood nearly white; not durable.

Growth.—Height, 60 to 90 feet; diameter, 1½ to 3 feet.

SUPPLY.

The commercial range of shortleaf pine lies principally in Alabama, Arkansas, Georgia, Louisiana, Missouri, North Carolina, South Carolina, and Texas. The lumber is known under many names in different localities, among them being yellow pine, spruce pine, bull pine, shortschat pine, pitch pine, poor pine, shortleaved yellow pine, rosemary pine, Virginia yellow pine, North Carolina yellow pine, North Carolina pine, Carolina pine, slash pine, and oldfield pine.

The botanical range of shortleaf pine is much more extensive than its commercial range. In many regions the growth is scattered, and only a few trees are found here and there. Early botanists reported the species as far north as Albany, N. Y., but it long ago disappeared from that latitude, and it is doubtful if it is now to be found north of central Pennsylvania. A century or more ago lumbermen cut large quantities of shortleaf pine on the main stream and tributaries of the Potomac and floated the logs to tidewater at Georgetown. The operations were west of the Blue Ridge, in contiguous parts of Maryland, Virginia, and Pennsylvania. Shortleaf pine has now ceased to exist as a source of lumber in that region.[1]

Thirty years ago the stand west of the Mississippi was estimated approximately at 95 billion feet. That was before much lumbering had been done in that part of its range. The largest cut of short-

[1] It is noteworthy that Indians who roamed through the Shenandoah Valley before its settlement by white people called the Shenandoah "Pine River," or, as the name was literally translated by Heckwelder, "River that flows past 'spruce pine.'" (William E. Connelley's Memoirs of John Heckwelder.)

leaf pine now comes from west of the Mississippi, in Texas, Arkansas, Louisiana, and Missouri. Estimates of the stand east of the Mississippi River would be hard to make, because the trees are scattered over 200,000 square miles, with dense timber growth scarcely anywhere.

The Commissioner of Corporations, in his report on the lumber industry in 1911, estimated the yellow-pine supply of the South to be 384 billion feet, of which 232 billion feet are of longleaf and 152 billion feet of shortleaf and loblolly combined.

It is the opinion of those who have studied the shortleaf pine's habit of growth and the extent of its natural range that it promises to continue one of the important timber trees of the South. If it fulfills that promise, however, it will be when better care has been taken of it than has been shown in the past. It has been exploited and abandoned to periodic forest fires, and the result is seen in a thin stand and a gradually contracting range. It possesses one advantage over nearly all other pines—the power to send up sprouts from stumps. The shortleaf pine's ability to send up sprouts is more pronounced west of the Mississippi than farther east.

EARLY USES.

The custom which has prevailed since early times of sending several species of pine to market under one name or many names renders it impossible to determine exactly to what extent shortleaf was used during the colonial period and later. It is known, however, that shortleaf was an important commodity more than 100 years ago. In fact, there is contemporaneous record that extensive cutting had depleted the supply a century ago along the Atlantic seaboard. It had gone to foreign countries, particularly to the West Indies, and at home it was a standard stock in shipyards at Baltimore, Philadelphia, New York, and Norfolk. It was used for masts, spars, yards, beams, planking, and interior lining, and for cabins and decks. The wood from New Jersey, Delaware, and the Eastern Shore of Maryland was generally considered finer grained and more compact than that grown farther south and back from the coast. Little or none is now cut in the coastal regions which once supplied the wood so highly esteemed for its excellent qualities.

Residences and farm buildings within the range of shortleaf pine and outside that of longleaf pine were largely built of it. It was seldom, however, the only wood used for that purpose. It was generally the floor material, the frames for doors and windows, and frequently the siding and ceiling. Where cypress or white cedar could be had for shingles, one or the other was usually employed, but in regions remote from the coast neither could be had, and in that case shingles were made from shortleaf pine, which often formed nine-tenths of the wood in a building. Farm fences and the pickets

that inclosed gardens and truck patches were of this pine in many instances. The heartwood was enduring, but the sap was disposed to decay quickly in damp situations.

Shortleaf pine was cut for fuel by the early residents throughout its range. It is rich in resin and burns brightly.

The high prices paid for naval stores during the colonial period and later directed attention to shortleaf pine. Some development followed, but it was not as profitable to the operator as longleaf pine, because the trees were more dispersed, operations more expensive, and the yield less. John Lawson, writing in 1714, listed pitch, tar, rosin, and turpentine as products of shortleaf pine in North Carolina.

MANUFACTURE AND PRODUCTS.

The uses of shortleaf pine are as varied as those of longleaf, and the two go together for many purposes, without preference or prejudice, but there are differences which sometimes lead to the choice of one or the other for certain special uses. Longleaf is considerably the heavier, though lighter in ash. It is also stronger and more elastic; consequently, when the architect desires timber to sustain pressure and withstand shocks, he decides in favor of longleaf; but in nearly all other situations shortleaf serves as well, and sometimes its lighter weight makes it more desirable than the other.

Furniture makers, who use yellow pine in considerable amounts, find shortleaf an admirable wood. It is worked into frames, goes into the interior of couches, tables, stands, and desks, and in the cheaper grades of similar articles it may appear as the outside visible part. The grain is handsome and shows well in natural finish or when stained.

Inside and outside trim for houses is manufactured from shortleaf pine. It is widely used for flooring and is recommended both by appearance and because of its wearing qualities. It responds readily to oils, wax, and other floor finishes and dressings. It answers equally well as wainscoting and ceiling, for chairboards, baseboards, brackets, molding, cornice, roseblocks, ornaments, carved work, spindles, balusters, railing, stairs, and panels. Window frames and frames for doors, and the doors themselves, and sash are largely manufactured from this wood. Plasterer's lath and shingles are products of shortleaf pine forests, and porch columns and porch flooring cause further demand upon the supply. Many of the large lumber mills of the South, particularly in Arkansas, Louisiana, and Texas, advertise shortleaf pine as a specialty, and are producing it in great quantities and in many forms.

Excelsior mills find the wood suitable for their purposes, and occasional use is made of it for pulp. Veneers of this pine enter largely into basket and box manufacture. Statistics showing the

output of veneer do not distinguish between different species of the southern yellow pines, and it is not possible to determine how much of the total belongs to shortleaf. The cut in 1908 in the United States classed as yellow pine was 42 million feet log scale. Red gum alone exceeded this amount. The veneer is manufactured into numerous commodities, among them berry baskets, fruit baskets, and vegetable barrels, boxes, and crates.

Slack coopers draw upon shortleaf for a large part of their material, but again statistics do not show the actual quantity supplied by this species.

The manufacturers of machinery, implements, tools, and apparatus make much use of shortleaf pine. It is specially valuable as wagon bottoms and cart beds, and for hoppers, drawers, boxes, chutes, and compartments in fanning mills, corn shellers, grain drills, thrashing machines, reapers, straw cutters, mowing machines, and in numerous other labor-saving machines and devices.

During 200 years it has held its place as material for ship and boat building, not only along the coast within a hundred miles or so of the supply, but in practically all ports of the country east of the Rocky Mountains where boat building is carried on as a business. It is fit wood for all parts of vessels from the frame to the mast, from rudder to prow. It is worked into decking, finish, cabins, lining, sides, railing, ladders, stairs, ceiling, seats, and nearly everything else of wood that is required in modern boat building.

LOBLOLLY PINE (Pinus tæda).

PHYSICAL PROPERTIES.

Weight of dry wood.—33.9 pounds per cubic foot (Sargent).

Specific gravity.—0.54.

Ash.—0.26 per cent of weight of dry wood (Sargent).

Fuel value.—73 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—12,300 pounds per square inch, or 77 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,628,000 pounds per square inch, or 77 per cent that of longleaf pine (Sargent).

Character and qualities.—Medium heavy, strong, and tough; grain coarse, even; annual rings variable, but mostly very wide; summerwood broad, resin more abundant than in shortleaf, less than in longleaf; resin passages numerous, not prominent; medullary rays numerous, obscure; heartwood orange yellow to light brown, the very thick sapwood light yellow or often nearly white; not durable, but takes preservative treatment readily; wood of the rosemary pine close grained, less resinous, lighter, with much thinner sap.

Growth.—Height, 70 to 120 feet; diameter, 2 to 4 feet.

SUPPLY.

Loblolly pine occurs commercially in Alabama, Arkansas, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, Okla-

homa, South Carolina, Texas, and Virginia, and is known under many names, among them old field pine, longshucks, black slash pine, frankincense pine, shortleaf pine, bull pine, Virginia pine, sap pine, meadow pine, cornstalk pine, black pine, foxtail pine, Indian pine, spruce pine, bastard pine, yellow pine, swamp pine, and long-straw pine.

Loblolly lumber which now reaches market is largely of second growth or has been cut on land where it formerly grew sparingly or not at all. It quickly takes possession of abandoned fields or tracts from which other timber has been cut, and it increases in size so rapidly that, where conditions are favorable, a tree 50 years old may cut three 16-foot sawlogs. Millions of feet of lumber have been cut from ground where old corn rows are still to be seen. Though the range of this tree has probably not been much extended since the country was settled, many areas and tracts have been partly or wholly taken possession of by it within that time. Perhaps no other species in the United States at present yields so large a lumber supply from second-growth forests. Its advance into abandoned agricultural lands in Virginia and North Carolina was noted by Michaux more than a century ago, and it has continued until the present time. In some localities the spread of loblolly pine was exceptionally rapid immediately after the Civil War, due to the abandonment of large areas on the southern plantations which before had been cultivated. Since that time the loblolly has spread from the primeval forest belts in Texas and in other regions west of the Mississippi into the prairies adjacent. Grassland which was treeless within the memory of living man has come up to pine seedlings. This has resulted from protection against fire. When the grass was burned yearly, as was once the rule, seedling pines could obtain no foothold, and the original forests bordering the prairies did well if they held the ground they already had.

The amount of loblolly pine timber in this country is not known. It covers 200,000 square miles, with a stand ranging from little or nothing in some parts to as high as 20,000 feet per acre or more in exceptional cases. Very large areas in almost all parts of the range of this tree are covered with more or less dense stands of timber in the sapling pole stage and which will not be merchantable before the expiration of 20, 30, or 40 years. Considering the stands of such young timber, it is hardly to be doubted that the area of fully stocked land is greater now than ever before.

Descriptions of the forests and of the country's resources contained in early histories and reports indicate that pine was not plentiful a short distance back from the coast of Virginia and North Carolina when the region was first explored. Hardwoods prevailed in many districts where pines pushed in later. However, at the beginning of

the nineteenth century the majority of the houses were of pine, which shows that if the wood was not originally abundant in the interior it spread there at an early date. Loblolly pine was cut by charcoal burners in large quantities, and was highly satisfactory for that purpose.[1]

EARLY USES.

There was an early trade in masts of rosemary pine cut in Virginia and North Carolina, and sticks of large dimensions were bought and sold. Rosemary pine was mature, well-grown loblolly, just as pumpkin pine in New England was white pine of large size and with exceptionally fine wood. The rosemary pine, as it was known and understood in early times, is very rare now. The regions producing it were long ago lumbered and the best timber culled out.

MANUFACTURE AND PRODUCTS.

As late as 1856 timbers of loblolly pine, which clearly belonged to the best class and were cut from the original forests, were hewed in North Carolina and sent through the Dismal Swamp Canal to Norfolk, whence they were shipped to New York. One cargo that was deemed worthy of special record was made up of squared timbers, with little or no sapwood and with solid contents ranging from 347 to 537 cubic feet each.

The wood parts of nearly all the buildings erected for the New Orleans World's Exposition were of loblolly pine cut in the Gulf region.

The use of this wood was greatly extended and its value increased when the custom of seasoning it in dry kilns became common. Prior to that time loblolly lumber frequently went to market green or imperfectly seasoned. It is largely sapwood, especially in medium-sized trees, and the water in it made it susceptible to attack by fungus, which gave a blue color to the wood and not only marred its appearance but induced deterioration. Thorough drying in well-constructed kilns removed the cause for that objection, and loblolly speedily won its way on its merits. Its range of uses is wide; it is sold in all the eastern and central parts of the United States and is exported to Europe and Central America.

A report of the woods used in Maryland for manufacturing purposes in 1909 gave first place to loblolly pine. In quantity it exceeded any two other woods, and in value was much above any other. Its nearest competitor in value was white oak. It exceeded all other

[1] In Robert Beverlye's History of Virginia, written 200 years ago, he referred to the promptness with which timber spread into open ground. There is little doubt that he had loblolly pine in mind when he said, "Wood grows at every man's door so fast that after it has been cut down it will, in 7 years' time, grow up again from seed to substantial firewood, and in 18 or 20 years it will come to be very good board timber."

woods combined (17 species were used) in the manufacture of boxes and crates, and was second in cooperage and basket making. Among the numerous commodities of which it forms part of the material or all of it are basket bottoms, vegetable crates, nail kegs, and boxes for fruits, vegetables, and bottles. It has a regular place in vehicle manufacturing for beds and bodies for wagons and carts, and in boat building for masts, siding, decking, lining, ceiling, cabins, and all kinds of finish and joiner work in skiffs, yachts, motor boats, and sailing craft. It is widely used by slack coopers. It is standard material for interior finish and is frequently employed on an equal footing with longleaf pine, which it closely resembles if pieces are carefully selected with regard to grain. It takes finish well, and if painted, as it usually is when used as weatherboarding, it wears well and needs repainting only at long intervals. It is excellent flooring lumber, and serves for practically all kinds of interior finish—window and door frames, ceiling, wainscoting, molding, railing, balusters, brackets, and stair work. Cabinetmakers work it into many articles, and it is seen in wardrobes, clothespresses, shelving, drawers, compartments, and boxes. It has no less a range of uses in furniture making, going for the most part into frames for couches, lounges, and large chairs.

A report of the wood-using industries of North Carolina in 1909 showed conditions similar to those in Maryland, in regard to loblolly pine. There more of it was used than of all other woods combined, the total being considerably more than 300 million feet. Practically every industry of the State that employed wood in manufacturing gave a prominent place to loblolly pine. Nearly 3 million feet were used for telephone cross-arms, it being practically the only wood employed for that purpose in the region. A comparatively large use in North Carolina is for tobacco hogsheads. Loblolly and longleaf pine aggregate 98 per cent of all the matched flooring manufactured in that State, but as the two woods are not listed separately in the statistics the proportion of each is unknown, except that most of it was loblolly.

RAILROAD TIMBERS.

Railroad companies buy large quantities of loblolly pine. It is used in car construction, chiefly for freight cars. It is employed in bridge and trestle work, though it does not rank with longleaf in strength or elasticity. It may be had in timbers that will compare in size with the best longleaf pine. Much is cut for crossties, but its tendency to speedy decay makes it unprofitable for that purpose unless it has been given preservative treatment. Loblolly pine is among the most easily treated timbers of the United States.

Loblolly mine props are largely used in the mines of the South and of Pennsylvania, and they are frequently given preservative treatment.

FUEL.

Few pines, if any, exceed loblolly in the extent of their use as fuel. Immense quantities are shipped as cordwood for domestic purposes and find markets in towns in the loblolly region, and also in cities as far north as Philadelphia. It has almost as wide a use for manufacturing purposes, particularly in brick burning, pottery kilns, and by bakers who demand a quick, hot fire.

CUBAN PINE (Pinus heterophylla).

PHYSICAL PROPERTIES.

Weight of dry wood.—46.1 pounds per cubic foot.

Specific gravity.—0.75.

Ash.—0.26 per cent of weight of dry wood (Sargent).

Fuel value.—Equal to white oak (Sargent).

Breaking strength (modulus of rupture).—16,400 pounds per square inch, or 102 per cent of that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—2,243,000 pounds per square inch, or 106 per cent that of longleaf pine (Sargent).

Character and qualities.—Very heavy, hard, strong, and tough; grain fine and straight; compact, annual rings wide, summerwood very broad, occupying fully half width of the annual growth; very resinous, conspicuous resin passages numerous, large; medullary rays numerous, rather prominent; color, rich dark orange, the sapwood lighter, often nearly white; durable.

Growth.—Height, 75 to 100 feet; diameter, 1½ to 3 feet.

SUPPLY.

The commercial range of Cuban pine lies in Alabama, Florida, Georgia, Louisiana, and South Carolina; and among the names by which it is known are slash pine, swamp pine, bastard pine, meadow pine, pitch pine, she pitch pine, she pine, and spruce pine.

The Cuban pine made a late entrance into the lumber supply of this country. Long after nearly all other trees that are associated with it were well known, this tree had no botanical name, and those who made use of the wood generally supposed they were using loblolly pine or longleaf pine. It bears some resemblance to both, but the foliage would scarcely be mistaken for longleaf. It was finally distinguished as a separate species, and upon better acquaintance it was found to possess many properties which give it value at present and promise it a place in this country's future timber supply. It does not exist in large quantity, compared with some of the other pines. Its range is limited to the coast of South Carolina, Georgia, Florida, and along the Gulf to Texas. It is the only pine in southern Florida,

and this gives it special importance there. It is a Cuban and Mexican tree, and its geographical location suggests that it may have entered the United States by way of the Florida Peninsula.

No estimate of stand has been made for this pine. It is dispersed, and is not found in all parts of its geographical range. It is aggressive and, possessing the ability to grow in the shade, it is pushing its way into the longleaf-pine districts and crowding that species out of some localities. In order to do this it must have the assistance of man or fire. Where lumbermen cut the longleaf pine, or where fire clears the ground, the Cuban pine gets a foothold and is generally able to hold it against all comers. It grows rapidly, overtops the young trees or other species, and shades them to death. Its rapid growth gives it an advantage over most of its associates in contending against fire. If it escapes for a short time it attains size sufficient to enable it to endure scorching that proves fatal to the smaller seedlings of other species. It reaches commercial size much earlier in life than the longleaf pine, and this adds a value to it. Trees 40 years old produce turpentine, and before they are much older they attain sizes fitting them for lumber.

MANUFACTURE AND PRODUCTS.

The fact that the Cuban pine has gone to market with longleaf and loblolly without any distinction being made indicates that its range of uses is, or may be made, as wide as theirs. It is stronger than either, and has greater elasticity. Its wood resembles loblolly more than longleaf, because it is of rapid growth and has wide annual rings. It was long ago used for shipbuilding, but those who used it supposed it to be loblolly pine. Though employed in boat yards for a number of purposes, the largest use was for masts and spars. It has a place among interior finish materials and is manufactured into door and window frames, sash, wainscoting, stair work, molding, ceiling, and flooring. It is employed for general construction purposes, including siding, porch posts, balusters, and railing. It meets all the general demands upon yellow pine in furniture making, agricultural machinery, farm timbers, and bridge building. Car shops employ it for beams, frames, lining, siding, ceiling, and roofing for freight cars, and it ranks high among the pines as a crosstie wood, and much of it is bought for that purpose. Its rapid growth is a factor of value, because young trees quickly reach the required size. This pine grows much to sap. Young trees are more than half sapwood, but in old trees the heartwood has the larger place. The wood yields readily to preservative treatment, and its period of service is greatly lengthened, especially when made into ties and laid in damp situations.

It seems probable that the Cuban pine will hold an important place in the future supply of naval stores. Its ample yield, the comparatively short period required for trees to attain the necessary size, and the vigor with which they spread to new ground and maintain their hold upon it, indicate that the species will figure prominently in future operations in the South.

POND PINE (Pinus serotina).

PHYSICAL PROPERTIES.

Dry weight of wood.—49.5 pounds per cubic foot (Sargent).

Specific gravity.—0.79 (Sargent).

Ash.—0.17 per cent of dry weight of wood (Sargent).

Fuel value.—107 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—16,300 pounds per square inch, or 101 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,670,000 pounds per square inch, or 79 per cent that of longleaf pine (Sargent).

Character and qualities.—Very heavy, strong, brittle, coarse grained, compact; summerwood broad, forming fully one-half the annual ring; very resinous; dark colored, conspicuous; resin passages few, large; medullary rays numerous, obscure; color, dark orange, the thick sapwood pale yellow.

Growth.—Diameter, 18 to 27 inches, in typical stands, but the trees are frequently small; height, 35 to 75 feet in typical stands.

SUPPLY.

This tree is often called marsh pine by lumbermen, and is also known as meadow pine, loblolly pine, spruce pine, bastard pine, and bull pine. Its range is restricted to the region near the coast, from Albemarle Sound in North Carolina to the head of St. Johns River. Fla. It appears also on the west coast of Florida, and ranges near the coast westward to the vicinity of Pensacola. Estimates of quantity place it much below the pines with which it is associated, which are longleaf, loblolly, and Cuban. Pure, dense stands of small area are frequently found, but it also grows with other species on low, poorly drained soils. Sometimes it takes possession of ground so poor and damp that other trees compete with it feebly or not at all. It does not invade the dry, sandy tracts where longleaf pine flourishes. It is a waste-place tree, and contents itself with sandy, wet tracts where it is comparatively free from crowding. In late years, however, it has shown a tendency to extend its range. It is usually looked upon as an abundant seeder, but careful observation modifies this view. Trees are generally full of cones, but the crops of several years hang to the branches, and the actual quantity of seeds dispersed in a single season is much smaller than the abundance of cones would indicate. The seeds are small and their wings are of ample size to carry them considerable distances, for which reason

the species' power of reproduction is sufficient to maintain a foothold and to extend it when conditions are favorable. Its rate of growth is not much less than that of loblolly pine, when soil, light, and drainage are just right; but it is unable to extend its range as its associate pines do, and for that reason there is little prospect that the pond pine will ever much increase its commercial importance. When crowded in close stands it clears itself of branches and makes a trunk suited for the sawmill, but the amount of sapwood is excessive, surpassing loblolly pine in that respect.

MANUFACTURE AND PRODUCTS.

Pond pine has been cut, sawed, and sold as loblolly in all parts of its range. Lumbermen often do not recognize the difference. The growing trees look much alike, and, except for the cones, one may be readily mistaken for the other. The wood of the two species bears close resemblance and is difficult to distinguish. Pond pine lumber has given good service as planing-mill output, such as flooring, ceiling, and interior finish. It has gone to practically all the markets where loblolly has gone, though in less quantity. In the region where it grows it has been used since the settlement of the country as a plantation timber, especially for fencing about rice fields and on the islands and near the coast, where Sea Island cotton is grown. It does not last well in contact with the ground, but within limited areas its abundance has made it the most economical wood for certain purposes. That part of the cut which has reached the manufacturing cities has answered the purposes of cheap furniture, particularly for couches.

BY-PRODUCTS.

Pond pine was formerly not considered by turpentine operators, but when the abundance of longleaf pine near the coast began to fail operators experimented with this species and found it of considerable value, but not equal to longleaf. The quality of the product is satisfactory, but the quantity per tree is smaller, and it costs more to get it. The streak or wound in the bark which produces the resin must be renewed oftener, and the annual period of production is shorter than for longleaf. It is claimed, further, that the tree sooner succumbs to the injury from tapping.

SPRUCE PINE (Pinus glabra).

PHYSICAL PROPERTIES.

Dry weight of wood.—24.5 pounds per cubic foot (Sargent).
Specific gravity.—0.39 (Sargent).
Ash.—0.45 per cent of dry weight of wood (Sargent).
Fuel value.—53 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—6,900 pounds per square inch, or 43 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—637,000 pounds per square inch, or 30 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, weak, brittle; grain coarse; summerwood narrow, not resinous; resin passages few, not large; medullary rays numerous, obscure; color light brown, the thick sapwood nearly white; not durable in contact with the ground.

Growth.—Height, 75 to 100 feet; diameter, 1½ to 3 feet.

SUPPLY AND USES.

Spruce pine is of minor importance, and apparently will remain so. This is due to scarcity and not to lack of value in the wood itself. It is softest of the southern pines and has been compared with white pine, and in some localities is known by that name. It is also known as cedar pine, poor pine, lowland spruce, and Walter's pine. The last name is in honor of its discoverer, who first described the tree in 1788. For seventy-odd years after that it was not recognized by any botanist, though the younger Michaux and others passed through the region where it grows. It is found near the coast of South Carolina and in restricted regions of Florida, Mississippi, and Louisiana. It nowhere forms pure forests, except in a few localities where second growth has taken possession of abandoned fields and in openings caused by timber cuttings. It is best developed in northwestern Florida, where trees reach maturity in about 75 years. Soon after that period the timber is apt to deteriorate through decay at the base and red heart at the top.

Though the wood is soft and has been compared in that respect with white pine, it resembles loblolly in appearance. The sapwood is thick, sometimes constituting three-fourths of the trunk of trees 75 years old. The wood shrinks about 10 per cent of its bulk in seasoning. Its fuel value is lower than the other southern pines, on account of its lack of resin. The want of resin excludes this tree from the list of pines valuable for naval stores and confines its value to its use as lumber only. A little of it is cut wherever mill operations are in progress within its range, but the lumber in the market is seldom distinguished from other pines that go with it.

SAND PINE (Pinus clausa).

PHYSICAL PROPERTIES.

Dry weight of wood.—34.75 pounds per cubic foot (Sargent)

Specific gravity.—0.56 (Sargent).

Ash.—0.31 per cent of dry weight of wood (Sargent).

Fuel value.—74 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—7,000 pounds per square inch, or 43 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—791,000 pounds to the square inch, or 37 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood medium heavy, soft, not strong, brittle; summerwood narrow and very resinous; resin passages numerous, prominent; medullary rays numerous, thin; color, light orange, or yellow; the thick sapwood ivory white.

Growth.—Best developed trees attain a height of 60 to 75 feet and rarely exceed 2 feet in diameter.

SUPPLY AND USES.

The sand pine is restricted in range and is usually small in size. A little of it is cut for fuel for local use about plantations, but for years it has given some service as masts for small vessels that fit out on the Gulf coast near where it grows. It is reported from only two States—northern Florida and southern Alabama. There is no reason to believe that the sand pine will ever become important. It withdraws itself to sandy dunes and barren ridges, where it frequently does not attain a height above 30 feet.

SCRUB PINE (Pinus virginiana).

PHYSICAL PROPERTIES.

Weight of dry wood.—33.19 pounds per cubic foot (Sargent).

Specific gravity.—0.5309 (Sargent).

Ash.—0.3 per cent of weight of dry wood (Sargent).

Fuel value.—71 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—9,200 pounds per square inch, or 57 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—766,000 pounds per square inch, or 36 per cent that of longleaf pine (Sargent).

Character and qualities.—Medium light, soft, not strong, brittle; wide-ringed, compact; grain fine and even; summerwood narrow, very resinous; resin passages few, not prominent; medullary rays numerous, thin; color, light orange, the thick sapwood nearly white; not durable in contact with the soil.

Growth.—Height, 50 to 90 feet; diameter, 1 to 2 feet; in some parts of its range it seldom attains to that size.

SUPPLY.

Scrub pine is not an important timber tree in either quality or quantity. It is known as Jersey pine, shortshucks, shortschat, spruce pine, shortleaved pine, cedar pine, river pine, nigger pine, and New Jersey pine, and is found in a region embracing perhaps 100,000 square miles in Alabama, Delaware, Kentucky, Maryland, North Carolina, New Jersey, Tennessee, and Virginia. In many parts of its range the trees are small and few. In other portions, however, the growth is heavy and the trees large enough for some of the common and cheap grades of lumber. Estimates of the total available quantity have not been made. In many localities it is regarded as an encumbrance rather than an asset, yet that estimate of the tree's

value and importance does not do it justice. In 1909, in the State of Maryland alone, 17,000,000 feet of this lumber were put to use, and its value at the box factories where it was manufactured was $173,000. In quantity it stood fifth in the State, being surpassed by loblolly pine, longleaf pine, white oak, and cypress, while 48 woods were below it in quantity. No statistics have been compiled to show how much of this wood is cut and used in other States, but there is no reason to suppose that Maryland uses more than New Jersey or Virginia, and it is well known that considerable quantities are cut in many parts of its range. Though the annual cut of all woods in Maryland amounts to about 450,000,000 board feet, only one species, loblolly pine, exceeds scrub pine in quantity. It has not sprung into use in recent years, but has been of value for generations and for many purposes. It is known that the stand was considerable in New Jersey long before the Revolution, and that tar makers cut large amounts of it in that State, as well as in Delaware, along the eastern shore of Maryland, and in the southeastern corner of Pennsylvania. At the beginning of the nineteenth century scrub pine seemed to be gaining in area in New Jersey, and was spreading into the open ground. The species is best developed west of the Allegheny Mountains. Its growth is rapid, and it quickly takes possession of abandoned farm land, forming dense stands. These reach early maturity, and then give way to hardwoods, unless the entire stand is cut down, since it can not reproduce in the shade.

USES.

The earliest use reported for scrub pine was in tar making in New Jersey prior to 1750. In certain parts of its range, particularly in Kentucky, it is still employed to a small extent by tar makers. In Indiana it is manufactured into pump legs and water pipes. It is widely used for fencing, though not in large quantities. So far as available statistics indicate, the two most important demands upon scrub pine come from box makers and cordwood cutters. The box and crate industry in Maryland in 1909 took the whole cut in that State, besides several million feet shipped from Virginia. The boxes were of many kinds, including those for fruit, vegetables, fish, oysters, and canned goods of many kinds. The logs that go to the mills are small and generally knotty. They are ripped through and through and the boards are afterwards run through edgers. This tree is also cut to a considerable extent for pulp. The pulp mills of southern Pennsylvania and West Virginia employ rather large quantities, obtaining the supply mainly from Virginia and Maryland.

A large demand for cordwood is met by this pine. In fuel value it ranks below longleaf, shortleaf, Cuban, and loblolly pines, but it finds ready market in all the cities and towns to which it is shipped.

TABLE MOUNTAIN PINE (Pinus pungens).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.75 pounds per cubic foot (Sargent).

Specific gravity.—0.49 (Sargent).

Ash.—0.27 per cent of weight of dry wood (Sargent).

Fuel value.—66 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,000 pounds per square inch, or 62 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,159,000 pounds per square inch, or 55 per cent that of longleaf pine (Sargent).

Property and qualities.—Wood medium light, soft, strong, tough, compact; grain rather coarse; summerwood broad, resinous, conspicuous; resin passages numerous, large; medullary rays numerous, prominent; color light brown, the thick sapwood nearly white; not durable in the ground.

Growth.—Height, 40 to 65 feet; diameter, 18 to 40 inches.

SUPPLY AND USES.

Except in a few localities the table mountain pine is not abundant, though its range includes parts of Pennsylvania, Maryland, District of Columbia, West Virginia, Virginia, Kentucky, Tennessee, Georgia, and North Carolina. It reaches its best development among the high mountains of eastern Tennessee, where on rocky ledges it sometimes is the prevailing forest tree, and in some parts of Pennsylvania it is rather plentiful. It is known also as prickly pine, hickory pine, and southern mountain pine. The timber is cut in all parts of its range, but is nowhere an important commodity. The largest recorded utilization of it has been in Pennsylvania, where considerable quantities have been made into charcoal. A few logs are sawed into lumber, which is never distinguished from other pines in the market. Some of it is cut for cordwood in Maryland and Pennsylvania, but its fuel value is below that of loblolly, pitch, or scrub pine. There is no reason to expect that the tree will ever attain greater importance than it now has.

PITCH PINE (Pinus rigida).

PHYSICAL PROPERTIES.

Weight of dry wood.—32 pounds per cubic foot (Sargent).

Specific gravity.—0.51 (Sargent).

Ash.—0.23 per cent of dry weight of wood (Sargent).

Fuel value.—70 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,300 pounds per square inch, or 64 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—838,000 pounds per square inch, or 39 per cent that of longleaf pine (Sargent).

Character and qualities.—Medium light and soft, strong, brittle, grain fine, uneven, and straight; annual rings rather wide; summerwood broad and distinct, very resinous; conspicuous resin passages numerous, large; medullary

rays few but prominent; color light brown or red, the thick sapwood yellow or often nearly white, not very easily worked, due to difference in hardness between spring and summer wood; fairly durable where used in contact with the earth.

***Growth.*—Height, 40 to 80 feet; diameter, 1½ to 3 feet.**

SUPPLY.

The botanical range of pitch pine covers half a million square miles, but its commercial range is much less. It is in sufficient quantity for use in Delaware, Georgia, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, and West Virginia. Among the different names by which it is known are longleaved pine, longschat pine, hard pine, yellow pine, black pine, black Norway pine, rigid pine, and sap pine.

No census of standing pitch pine in the United States has been taken, and the amount is unknown. No extensive forests exist, but it is dispersed widely, with small tracts of fairly dense stand. An average stand of 100 feet per acre would be a liberal estimate for an area of 100,000 square miles. The quantity used in Maryland in 1909 was about 625,000 feet, reported by manufacturers, and in Massachusetts about 887,000 feet.

The pitch pine is one of the trees which maintains its place in the forests in the face of adversity. It must have light or it can not grow; and in order to secure light it retreats to poor tracts and sterile ridges where few other species can exist. It meets poor success when it endeavors to extend its range into areas where other trees can overtop it. If ability to grow on poor land were the only factor in its favor, its struggle against adversity would end in failure. Its resistance to fire, however, is remarkable, and its seedlings frequently survive when all others are killed. On a certain tract it was found that fire killed 66 white pines to 1 pitch pine where size, number, and situation of the two species were similar. It has an advantage also in scattering its seeds, which are light and may be carried considerable distances by the wind, and which are released from the cones only in dry weather.

It is not probable that pitch pine will ever be extensively planted for the purpose of producing timber, for many other species grow more rapidly and promise better returns; but in certain localities, such as poor ridges and sandy tracts, it may pay to grow the tree.

EARLY USES.

Pitch pine supplied many needs of the early settlers, though in but few localities could it properly be classed as the most important tree. Over wide regions it was the chief source of tar, and it was not

unusual for each farmer to manufacture what he needed. Such manufacture was necessarily on a small scale and by crude methods. The tree's resin accumulates at the base of the branches, and the rural tar makers ordinarily made use of knots in preference to the clear wood of the trunk. Though the method used was a crude and simple process of destructive distillation, it produced a grade of tar which answered most purposes well. The tar's chief use among country people in early times was one which has now practically passed away. It was the best axle grease for wagons that could then be had, and the wagon without its tar bucket and its tar paddle, swinging from the rear axle, was seldom seen.

By subjecting the pitch-pine knots to a different treatment—a sort of steam distillation—shoemaker's wax was produced. This commodity was widely manufactured, but usually in very small quantities. The shoemaker was in every community and in most houses. The linen thread with which the home-tanned leather was sewed was rubbed with wax, and was then called "wax ends."

Lampblack was made of pitch pine long before it was made from natural gas, and the wood was one of the earliest put to use by charcoal burners. In the manufacture of charcoal the tar and other by-products were wasted, as no apparatus was devised to save them. The charcoal was in demand for blacksmith shops and iron furnaces.

Pitch pine had another extensive use in early times, which might seem unimportant when considered from the standpoint of the present. It was a substitute for the candle and the lamp at a time and in places where it was frequently impossible to obtain either. Splinters that burned with a steady flame afforded light in many a frontier cabin. The gathering of pine knots was as carefully attended to as the cutting of the winter's wood or the cribbing of the corn crop. The knots being rich in resin remained sound long after the prostrate trunk lying in the woods had decayed. That made the gathering of the knots an easy task. It was frequently done by driving an ox sled through the woods in the fall, where pitch pines had fallen and decayed, and picking up the knots that lay in rows on the surface of the ground.

Fagots, split from the bodywood of this pine, in early times and in regions where the trees grew often served for out-of-door light. Torches made of small split pieces bound together in bundles 4 or 5 feet long with hickory or yellow birch withes lighted the way on night journeys through the woods. Men who speared fish at night in the rivers and creeks had nothing better than the light from the pitch-pine torch. Hunters who went by boats along the shores of lakes and rivers "shined the eyes" of deer by that method.

FARM TIMBER AND BOAT BUILDING.

The builders of water mills in early times found that pitch pine was peculiarly well suited for wheels that worked in damp situations, and it was made into overshot, undershot, breast, and flutter wheels, being used for both buckets and spokes. Its principal virtue was its resistance to decay. For the same reason, timbers largely of heartwood were hewed for barn sills and sleepers and as foundation logs for various buildings. The wood was made into fences to a considerable extent, especially board fences with locust posts. It is occasionally so used still. Along the Atlantic seaboard boat makers drew supplies from pitch pine at a time when other woods were abundant; but the amount so used was not large in comparison with white pine, oak, and red and white cedar. In recent years considerable quantities of pitch pine have been used for boat building. It was in early use for ship pumps, the heartwood only being employed for that purpose. It was available in long stock, and, as with Norway pine, was liked for that reason by pump makers.

MANUFACTURING.

Bridge timbers and other beams for heavy construction are cut from pitch pine, though it is seldom highly recommended for uses which demand stiffness. Its botanical name, *Pinus rigida*, would seem to indicate that the wood's chief characteristic is stiffness, but the reference is to the leaves and not to the wood. In fact, in comparison with the pines, its elasticity is in the lowest rank, and not half that of longleaf. Some use has been made of it for railway ties. The chief objection to it, aside from its tendency to decay, which is common to nearly all pines, has been its poor holding power on spikes. Shipbuilders complain of it in the same way, and in certain parts of vessels where strain is great it is not advisable to employ it unless reenforced by oak or some other wood that holds spikes well. It has also been used extensively in Pennsylvania for mine props. In this capacity it comes into competition with loblolly and longleaf pine. In the mines the real test comes on durability. Pitch pine is more durable than loblolly, but less durable than longleaf.

One of the largest uses for pitch pine is for box and crate making. In quantity, however, it is far below other pines associated with it. In Massachusetts, in 1909, box makers used 600,000 feet of pitch pine and 263,000,000 feet of white pine, and in Maryland they used 615,000 feet of pitch pine and 70,000,000 of loblolly.

Pitch pine floors wear well, look well, and have long been in use. In Pike County, Pa., a pitch pine floor, laid with boards 2 feet wide

and 1½ inches thick, did service 160 years, and was still in such good condition that the boards were relaid for flooring in a new house.[1]

The wood answers well for door and window frames, ceiling, and other interior finish. Objection to the numerous knots which the wood contains is occasionally made. The knots are filled with resin and are often of much deeper color than the clear wood. Where handsome appearance is desired, therefore, pitch pine must be carefully selected, or it will not answer.

Makers of slack cooperage work this wood to advantage for barrel headings, crates, and nail kegs.

Vehicle manufacturers employ it for beds for wagons. Its largest users are said to be blacksmiths in small country towns, who make wagons as a side line and draw supplies from local sawmills.

It serves many purposes in furniture making, chiefly, however, as an inside material, since the knots are frequently considered as blemishes. It is given place in cupboards, ice chests, kitchen cabinets, tables, and as shelving and drawers in desks and clothespresses.

Pitch pine piles are employed in the construction of wharves and bridges. The wood is cut into excelsior and is made into pulp. It is widely sold for fuel in brick kilns, potteries, bakeries, steam engines, and for domestic purposes.

WHITE PINE (Pinus strobus).

PHYSICAL PROPERTIES.

Dry weight of wood.—24 pounds per cubic foot (Sargent).

Specific gravity.—0.385 (Sargent).

Ash.—0.19 per cent of dry weight of wood (Sargent).

Fuel value.—51 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—8,800 pounds per square inch, or 55 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,208,000 pounds per square inch, or 57 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong, grain fine, straight and even; annual rings quite wide in young growth; compact; summerwood thin, not conspicuous, resin passages small, not numerous or conspicuous; medullary rays numerous, thin; color light brown, often slightly tinged with red, the sapwood nearly white; easily worked, susceptible of a good polish; heartwood durable in contact with the soil.

Growth.—Diameter from 4 to 6 feet, but larger trees were formerly found. In extreme cases diameters above 7 feet have been known. The height is usually from 75 to 120 feet, but individuals have been recorded nearly or quite 240 feet. It is doubtful if any other species east of the Rocky Mountains has produced specimens of equal height.

SUPPLY.

White pine occurred originally in commercial quantities in Connecticut, Delaware, Georgia, Illinois, Indiana, Kentucky, Maine,

[1] History of the Lumber Industry in America, J. E. Defebaugh, vol. 2, p. 563.

Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania; Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin.

The cut has probably exceeded that of any other species. Several timber trees have a wider commercial range, and at the present time two yield more lumber yearly—Douglas fir and longleaf pine—but white pine was the leader in the markets for 250 years. Though to-day the original forests of this species are mere fragments of what they once were, the second growth in some regions is meeting heavy demand. In Massachusetts, for example, the cut in 1908 was 238 million feet, and practically all of it was second growth. It is not improbable that a similar cut can be made every year in the future from the natural growth of white pine in that State. It might be shown by a simple calculation that if one-tenth of the original white pine region were kept in well-protected second growth, like that in Massachusetts, it would yield annual crops, successively for all time, as large as the white pine cut in the United States in 1908. To do this would require the growth of only 25 cubic feet of wood per acre each year, and good white pine growth will easily double that amount. The supply of white pine lumber need never fail in this country, provided a moderate area is kept producing as a result of proper care.

During the past 30 years the largest cut of white pine has come from the Lake States—Michigan, Wisconsin, and Minnesota. At an earlier period it was from Pennsylvania and New York, and still earlier the center of supply was New England. The output from the Lake States in 1908 was about 30 per cent of that in 1892. This decrease in output was due to depletion of the forests. The original pineries have largely been cut out, and though for some time there will be old-growth pine in the market, the bulk of the future supply must come from new growth. No large region of virgin timber remains. It is not to be expected that this country will ever again see the quality of this lumber it has seen in the past. The large, clear timber, such as once came from the northern pine regions, will never come from there again, because it was sawed or hewed from trees centuries old. It is too much to expect that forests of second growth will be permitted to attain that age or that the owners of trees will wait for them to attain a height of 150 and a diameter of 4 feet.

Estimates of the total quantity of this pine in the original forests of the United States should be regarded as approximations only. The area, excluding Canadian territory, was approximately 350,000 square miles. If it is assumed that the stand averaged 2,000 feet per acre, the total was 450 billion feet. That estimate would appear

conservative in view of the fact that a considerable part of the original pine forest produced 10,000 feet per acre and the actual amount of this pine marketed from Michigan, Wisconsin, and Illinois has exceeded 200 billion board feet.

EARLY DEVELOPMENT.

When the earliest colonists landed in New England they found the coast in most places densely wooded with white pine, and the valleys were filled with it. There are records, apparently well authenticated, of trees 240 feet high, and the extreme limit of 270 feet was claimed for one that stood on the site of Dartmouth College. The cutting of this timber began at once. Within 15 years after the settlement at Plymouth a cargo of masts was shipped to England, and from that time on the trade between New England and the mother country was maintained. Within 30 years after the landing of the Pilgrim Fathers the people of New England were sending white pine to Madagascar and Guinea in Africa, where it was exchanged for slaves for the Virginia and the West Indies trade. Exchanges of the timber were also made for other than human chattels. The Canary Islands, which produced wine, bought pine staves from Massachusetts and paid in wine, while Cuba, Haiti, and other sugar islands exchanged sugar for barrel and hogshead staves. A foreign trade, very large for that time, was carried on with white-pine timbers cut on the Piscataqua River, and in 1650 fears were expressed that the drain would exhaust the supply. This was within 30 years after the first permanent settlement on the New England coast, and at that time, as is now known, the primeval forests had scarcely been touched. The people had an erroneous idea of their extent, and many years after the first alarm was sounded there came another, which drew from Joshua McGee the reply that the cutting of a few hundred masts a year would make little inroad upon America's forests, which were, he said, "14 or 15 miles long and 300 to 400 miles broad."[1]

As late as 1706 there were only 70 sawmills on the Piscataqua River, which was the center of the white-pine operations. Yet they were numerous enough to have made serious inroads upon the forests had they been larger. They were of the sash-saw style, were operated by water power, and their capacity ranged from 1,000 to 3,000 feet each per day. All of them combined did not cut as much as one large modern mill. Sawing lumber by hand, as was the only

[1] Industrial Experiments in British Colonies in North America, E. L. Lord, p. 77. The word "long" was here used to denote longitude in its geographical sense, and "broad" meant latitude. The meaning was that the pine forests extended 300 or 400 miles north and south along the coast and 14 or 15 miles east and west, or inward from the coast. The manner of expressing the forest's extent shows how little was then known of its real dimensions.

method in England at that time, was carried on little, if at all, in New England. It appears not to have been the actual cut of the mills, but the waste, which constituted the serious drain on the forests. It was claimed that only one tree in four was saved, the others being destroyed. Only the best trees, and the best parts of the best trees, were taken. It frequently happened that half a log was cut off and thrown away as slabs. At Bangor the accumulation of slabs thrown into the river was so great that the channel was blocked, and passageways for vessels were cleared at great cost. Slabs were not the only part thrown into the river, for it is on record that so much good lumber was dumped in the stream that a boy in one summer was able to drag out enough to build a house. The markets where the early white-pine lumbermen found sale for their commodity demanded the highest quality, and the mill men met the demand with little regard for the resulting waste. In 1700 the New Hampshire lumbermen met, without recorded complaint, the demands of a market which insisted upon having white-pine planks 25 feet long and 15 or 18 inches wide, and for ship decks 36 feet long and 3 feet wide.

Early records are not available showing consecutive yearly exports of white pine from the different parts of New England, but isolated items are known. In 1671 the exports from New Hampshire totaled 200,000 tons of planks and pipe staves. In 1699 a timber trade began with Portugal, and it called forth most vigorous protests from merchants in England, who insisted that the colonists should do their trading through mercantile agencies in the mother country. The aggregate of the Portugal transactions does not appear to have been large, compared with modern lumber operations. One of the most vigorous protests was called forth when a New England ship captain at an expenditure of only $300 cleared $1,600 by carrying lumber to Portugal. His report of possibilities caused a sensation among the owners of white-pine lumber, and five vessels went to Portugal in one fleet carrying masts, spars, and other ship timbers. Reports of the exports to Portugal for six years, 1712–1718, when figured out by modern measurements, did not much exceed 2,000,000 feet, or one modern shipload—scarcely enough, it would seem, to justify an angry controversy between the merchants in England and the white-pine lumbermen in America.

More than a century ago the French botanist, Michaux, speaking particularly of New England, New York, and Pennsylvania, said that the white-pine lumberman kept 25 or 30 years in advance of the farmer, his meaning being that the land was stripped of its pine that long before it was brought under cultivation. He had in mind the constant western movement of settlements. His observation might need amendment before it could be applied in all parts of the white-

pine region and to all periods, yet, in a general way, the cutters of white pine have formed development's vanguard in the advance across the pine region from Maine to Minnesota. The white pine's lightness, which made it easy to float, was a factor in development which can scarcely be overestimated. Every navigable river or floatable stream was a highway for the transportation of the pine within reach of it. The enormous drives of pine logs once seen upon the rivers of Maine, Pennsylvania, and Michigan will probably never again be equaled anywhere. Had white pine been as heavy as red oak, lumbering operations in its region would have followed different lines, and the building of railroads would have preceded the marketing of the timber.

When the purchase of Louisiana in 1803 put an end to restrictions which had hampered trade on the lower Mississippi, one of the first commodities to feel and respond to the stimulus was the white pine on the head of the Allegheny River in northwestern Pennsylvania and southwestern New York. A fine quality grew in that region and was frequently known as cork pine. Rafts were sent down from the headwaters of the Allegheny River, 100 to 200 miles above Pittsburg, and made the long journey to New Orleans, more than 2,000 miles, measuring the windings of the river. Sales were made at $40 a thousand, which made the business highly profitable to the lumberman. The raftsmen were accustomed to return on foot from New Orleans to Pittsburg. Record exists of a white-pine raft which, when it passed Cincinnati, covered 2 acres, and contained a million and a half feet of lumber. The difference in early prices at Pittsburg, and at New Orleans was striking. A shipment at Pittsburg, a few years after trade began with New Orleans, sold at $5 a thousand, and half the pay was taken in window glass.

WHITE PINE LUMBERING.

The cutting of white pine has been a unique and interesting chapter in this country's industrial history. This does not apply to the marketing of the lumber so much as to the operations in the woods before the logs reached the sawmills. It is largely a thing of the past and has become history—a record of two and a half centuries of conditions never known before and which can never occur again. During two and a half centuries the cutters of this timber followed the retreating pine forest frontier westward from the coast of Maine to the source of the Mississippi. Conditions at the close of the period were very different from those at the beginning, but the white pine lumberman, with resourcefulness and ingenuity that challenge admiration, was equal to every demand upon him, met every emergency that arose, and again and again changed his methods to conform to changed conditions. Nowhere else has forest development exhibited so much

of romance and human interest. The cypress lumberman has been resourceful in his operations upon submerged lands; the yellow pine operators have cut the primeval timber harvest from a wide area; the cutters of white oak and yellow poplar have worked as long and have gone as far, but they have done it without stamping their individuality upon the history they have made. The men who have logged and milled the California redwood accomplished much on a small area, and over a wider region the Douglas fir has been the means of enormous development. But none of these compare with white pine in the absorbing and peculiar interest that pervades its history.

The first lumbermen on the New England coast had everything to learn by experience. They brought no forest lore with them from the mother country, for England was a land without a sawmill. They began with rude tools and on a small scale. There were no great lumber camps, but a multitude of small, individual enterprises. No large operations were carried on in New England in early times, though much business was done. White pine ship timbers were brought down to the sea by ox teams or were floated on the streams.

When the white pine operators reached New York and northern Pennsylvania, they found it necessary to carry on their work in a different way. They put the watercourses to more use, or used them over a larger region. Practically the whole State of New York was a continuous forest of white pine, and much of Pennsylvania was the same. The best of the timber near the lower Hudson River was cut very early by settlers, and that part of the stream was never much used for rafts and log drives. The stream could not be used in that way, for the current, because of the tides which ebb and flow twice a day, is too weak to carry floating objects down, unless the wind happens to be in the right quarter at the right time. Log drives on streams farther west became common. Floods were depended upon to carry the rafts or the loose logs in the streams. They were transported in that way from forests to the mills, sometimes a hundred miles or more. That made operations on a large scale not only possible but necessary. Some of the rivers of western New York flow through lakes where there is practically no current. When the drive of logs arrived at such a lake, they spread out upon the surface, and the wind drove them back and forth, scattering them and stranding many of them upon the shores. The lumberman's ingenuity was called upon to overcome that difficulty, and it was done by bunching the logs by passing a long cable around them and thus keeping them from separating and scattering. The logs were held in a body by that means, but the current was not sufficient to carry them down the lake to the outlet. To overcome that difficulty, windlasses were erected at certain points along the shore, and by means of ropes attached to the logs they were warped down the lakes, often against

head winds, until the current of the outflow caught them and carried them upon their journey.

The log drives and the rafting in the State of New York were small in comparison with those upon the rivers which flowed south through Pennsylvania—that is, the Delaware, the Susquehanna, and the Allegheny. The pine forests on the heads of those streams supplied large operators for many years. The Delaware was earliest in point of time, and Philadelphia was the chief market. The Susquehanna followed, with its sources in the great pine forests of New York and Northern Pennsylvania. Many of the head streams were too small and rough for rafting, and the logs were driven out on the crests of floods or by the aid of splash dams. These were built to impound the water and create artificial floods from time to time by opening the gates. When the logs had been carried to the larger streams they were either sawed into lumber or were collected in rafts to be sent farther down. The Susquehanna was regarded as a more difficult and dangerous stream than either the Delaware or the Allegheny. It had more rapids, more dams, sharper bends, swifter currents, and called for more skill and alertness on the part of raftsmen. The rivermen looked upon themselves as professionals, and were proud of their calling. Rafts usually floated 40 to 50 miles a day, and at night were tied to trees on the banks. Instances are on record of rafts from far up the Susquehanna which passed the length of the river and floated down Chesapeake Bay to Norfolk, Va., where the lumber reached a market. The passage down the bay was made with the assistance of the towing tugs.

The white pine forests of New York and Pennsylvania ended at Lake Ontario and Lake Erie, but beyond these lakes, in Canada and farther on in Michigan, Wisconsin, and Minnesota, they continued almost unbroken for hundreds of miles, wherever there was land. In that region of the lakes the largest and last of the primeval white pine forests of this country stood and there was carried on a system of lumbering which was in many ways unique and peculiar, with nothing else like it in our forest history. All the accumulated experience gained in 200 years among the pineries of New England, New York, and Pennsylvania was carried to Michigan, and was there turned to account in harvesting the vast timber wealth of that region.

Early lumbering there was on a small scale, as in other parts of the country, but when the demand came for the clear, soft pine of Michigan lumbermen were ready to provide it. Land was cheap, and for all practical purposes it seemed limitless. It was easy to acquire and passed rapidly into the hands of private owners or corporations. Cruisers, popularly known as "landlookers," were sent into the woods to locate choice tracts, which were bought up by capitalists. When a body of timber of sufficient extent was secured a

camp was established and the cutting began. Care was not always taken to procure lawful title. Timber stealing from public lands was common in that region, as it had been in New York and New England earlier and as it was in the Western States at a later period. The owner of a tract sometimes cut more timber from surrounding land than from his own.

Operations were usually on a large scale. The camp was an aggregation of buildings so situated that a large area could be worked from that center. It consisted of a cookhouse, bunkhouse, store, office, and stables. The number of men in a camp varied from 20 or less to 100 or more. The hours of work in winter were from daylight till dark, with extra hours for teamsters and cooks. The most of the work at such camps was done in winter, and the logs were made ready for the spring drives on the rivers. The cutting was done with axes and saws—chiefly saws. That was different from the early lumbering in New England, where saws were scarce and expensive and the trees were not only felled with axes, but the logs were cut off by the same tool, with extra chopping to square the ends. The peavy—a cant hook with a pike attachment—was in universal use in the Michigan lumber regions. Roads were cut in summer to be ready for winter. They led from different parts of the tract to points on the drivable streams where the logs were banked ready for floating.

The cold was seldom or never severe enough in the northern woods to keep the log cutters from their work, and from the first cool days of autumn till the snow began to melt in the spring the felling of trees and the hauling of logs were pushed with tireless energy. Camp competed with camp and crew with crew in turning out good work and plenty of it.

The landings along the streams were piled high with logs by the opening of spring. Millions of feet were ready for the freshets that followed the melting of the snow and the warm rains, and then came the crisis which was to determine whether the long winter's work was to end in complete success or partial failure. The winter's cut must be driven downstream to the mills. If the drive should lag and the falling water find logs still on the way and hung up on bars and ledges, the loss must be considerable, for white-pine logs left all summer are apt to be damaged by the discoloring of the sapwood or by the activity of worms. It was, therefore, a matter of importance that the logs should be safely delivered in the boom at the mill before the spring freshets subsided. The drive was the most trying time of the year. The men worked cheerfully from daylight to dark, nor grumbled if extra hours were required far into the night. It was a time of excessive toil, much excitement, and constant danger. Logs, piled high at the landings, might precipitate themselves with fatal

results upon the men who were skidding them into the river. There were jams in the streams to be broken, and the work was perilous. The men acquired skill in riding single logs down rapids, but sometimes the spiked shoes on which the rider depended failed at the critical moment or from some other cause he lost his balance on the whirling log and was thrown into the icy stream. He usually saved himself, but not always. It was a remarkable fact that some men who could not swim followed and took part in the log drives for years, escaping from every peril, while good swimmers sometimes lost their lives by drowning.

Many large operators built steam log roads from the forest to the mill, and did not depend upon the rivers to bring the logs down. That arrangement was more dependable than the spring flood, though less spectacular. Operations then went on the whole year through, both at the woods and at the mill. The steam log loader lightened the work of the cant-hook men by lifting the timber and placing it on the car, and many other labor-saving devices were introduced during the period when the bulk of the Lake States timber was going to market.

The decline in the output was as rapid as the rise. Year by year vast tracts of white pine were cut out and left barren, and the lumbermen moved to new locations; but the time finally arrived when no extensive new tracts remained and the golden age of white-pine lumbering passed into history.

SHIPBUILDING.

White pine has entered extensively into shipbuilding in this country ever since the first yards were established. In 1668 this industry had reached importance in New England, and by 1721 Massachusetts alone was launching annually from 140 to 160 vessels. Vessels were seldom or never made entirely of white pine, but for certain parts it was unexcelled. It is weaker than the Riga pine, which was its chief competitor one and two centuries ago, but it is lighter, and that was an important consideration. Masts other than white pine were seldom seen on New England ships. The wood was liable to quicker decay than the Riga pine at points of intersection with other timbers and below deck, but a preservative treatment was early put in practice. This consisted in boring holes in the tops of the masts and filling them with oil, which gradually penetrated downward, and it was claimed for it that it prevented decay. Not only were pine masts, yards, and bowsprits extensively used in American shipyards, but in English yards as well. The Revolutionary War interrupted exportations, but by 1789 shipments were again crossing the Atlantic, and houses in Scotland began to be finished in white pine.[1]

[1] European Commerce, J. J. Oddy, London, 1805.

For spars a length of 114 feet and a diameter of 38 inches were often specified. When Philadelphia became an important mast market, the timbers being floated down the Delaware River, it was customary to regulate the price by the diameter in inches 12 feet from the ground. A common price was $1.50 for every inch in diameter.

The figureheads for New England-built vessels were generally carved from white pine, and for this purpose the best parts of large, old trees were selected—called pumpkin pine, from the fact that the grain of the wood was highly homogeneous and could be cut in all directions, like a pumpkin, a quality appreciated by the carver.

Pine suitable for masts had become scarce by the beginning of the nineteenth century in many regions where excellent timbers of that kind were formerly cut. In 1805 Michaux did not see a single white-pine tree suitable for a mast for a 600-ton vessel during a journey of 600 miles from Philadelphia to Boston and beyond.

White pine has been and still is valuable for many parts of boat and ship construction, besides masts, yards, and bowsprits. In 1750 white-pine canoes, hewed from single trunks, were common at Albany, N. Y., and they were counted good for 8 to 12 years of service.[1] Yellow poplar was the chief canoe wood farther south and west. White-pine batteaux plied the Hudson, and doubtless other eastern rivers, before the French and Indian War. Albany was an important center of the white-pine lumber trade, and as late as 1806 the product was hauled on sleds from Skeensborough to that place, a distance of 70 miles.

At the present time the high price of white pine excludes it from some of its former uses in shipbuilding. Douglas fir from the Pacific coast is largely substituted in spars and yards. In smaller vessels, particularly in yachts, it is a favorite deck material, and it is used in fishing dories.

BRIDGES.

Within the white pine region it has been a valuable and much-used bridge timber. Its breaking strength is 45 per cent under that of longleaf pine of the South, and where strain is great it is inferior to longleaf for bridges. There are, however, many parts of bridge construction where great strength is not the chief requisite, and in such places white pine finds its best use. It has sufficient strength, if employed in adequate sizes, for any part of small and medium-sized

[1] The Indians of New York were using white-pine canoes when Europeans began to occupy the country, and had probably done so long before. The National Museum at Washington, D. C., has a portion of a pine canoe which is believed to be prehistoric. It was discovered in 1893, buried in mud near Lake Petonia, Chenango County, N. Y. It shows charred wood, and may have been hollowed by fire, a method often employed by savages in canoe making. The workmanship is crude, some parts of the shell being much thicker than other parts, and the canoe possesses none of the graceful lines so frequently associated with the handicraft of Indians. Other white-pine canoes made by New York Indians are in existence, but they do not date beyond the period of edged tools.

bridges, and in some notable instances it has been the chief or sole material of large bridges. It was used in the early structures spanning the Schuylkill River at Philadelphia, and the timbers in one of them were found in good condition after 37 years. The Delaware River at Trenton was likewise bridged with white pine, and it formed a large part of a bridge connecting Boston with Cambridge. The aqueduct over the Allegheny River at Pittsburg, by which the State canal crossed the stream, was built of white pine. It was 16 feet wide and 1,020 feet long, with 7 spans.

Many of the bridges in the interior of Pennsylvania and in West Virginia, by which the old pikes crossed the numerous streams, were built of white pine, and it was said of some of them that no man had lived long enough to witness their building and their failure through decay. Some of these structures were marvels in efficiency. Extra large timbers were unnecessary, and though slight in appearance, they carried every load that came during periods often exceeding half a century. They were roofed—usually with white pine shingles—and were weatherboarded with white pine or yellow poplar, and though painted only once or twice in a generation they stood almost immune from decay.

HOUSES.

An estimate made at the beginning of the nineteenth century by a traveler who had visited all the eastern portions of the United States was that 500,000 houses, exclusive of those in cities, were built of white pine.[1] He said that three out of four of the buildings of Pittsburg, Wheeling, and other towns on the Ohio River were wholly or largely of that wood. It was the material of rough construction and of inside and outside finish. It was sometimes stained to imitate cherry and mahogany, but was generally left in its natural color, with only a finish of oil, or with none. All through New England and New York it was a common building material while it was abundant. The finest residences and the humblest cottages employed it. It was manufactured into thin shingles and into the heaviest beams for churches and other large structures. When window sash was manufactured by hand no wood was better than the clear, soft, white pine. The carpenter could do more with it, and with less effort, than with any other wood. Many old houses of New England that were built before the Revolutionary War exhibit the excellent service white pine will give as interior finish. The Hancock House at Lexington, Mass., has panel work that was old when the opening battle of the Revolution was fought there. Some of the wood was finished in imitation of mahogany, and occasionally it is mistaken for that wood by visitors

[1] A. F. Michaux.

who judge it by its color only. The belfry where hung the lights which signaled Paul Revere to rouse the minute men on the morning of the fight was of white pine, clear, straight, soft, and of a rich color which a century and a third had not changed when the belfry fell.

The use of white pine for all classes of buildings is less than formerly, because the total cut in the country is not now half of what it once was. Increased cost has driven it from many places which it once held and cheaper woods have been substituted, yet it holds its own in higher class structures. It may be quarter-sawed, and presents an attractive grain. Large quantities of lath are made from slabs or inferior logs. Such material was once thrown away. Window sash made by machinery has taken the place of the handmade article of years ago, but the same high-grade lumber is demanded. White-pine doors meet a large and exacting demand. The light weight of the wood, its cheerful color, and its freedom from warping give it a value in almost every market. It is too soft for floors which are subject to excessive wear, but is excellent in certain situations. As siding, it has few equals. It paints well, holds its form, lasts a long time, and its appearance is attractive. The same properties fit it for ceiling, molding, panels, brackets, and railing. It is extensively used for shelves in cupboards, pantries, and fruit closets. Few woods equal it for outside and inside window blinds.

The white pine that grows in the Southern Appalachians is botanically the same as the northern species, but the character and the appearance of the wood are different. The homogeneous-grained pumpkin pine of New England and the cork pine of New York and Pennsylvania are not found in the South. The lumber from the southern tree is harder and is usually tinged with red. Its knots are generally round and sound, and often red. It never produces as much clear lumber as the northern pine, and the southern representative of the species seldom forms extensive pure forests.

SHINGLES.

The number of shingles made from white pine in the United States has been enormous. The three States, Michigan, Wisconsin, and Minnesota, produced 85 billion in 24 years. Shingles have been made of this wood since the earliest settlements of New England. For two centuries they were made by the slow process of hand work. The logs were cut into bolts by hand, rived with a frow, and the shingles were shaved with a drawing knife, the only other machine being a "shaving horse," a contrivance for holding the shingle while the manufacture went on. It was a slow process, and the man who could rive and shave 500 shingles in a day was fully up to the average of his craft. That many shingles sold for a dollar or two, depending upon time and place. The rustic shingle maker was an

expert in his line, and was supposed to be able to tell from a pine tree's general appearance whether it would "rive." He was at liberty, however, to test any trees he pleased by "blocking" them—cutting a large block out of the side of a standing tree to sample its splitting properties. If it did not suit, he passed on, leaving the blocked tree a prey to the next forest fire that would ignite the resin which accumulated in and about the wound.

The pioneer custom in Kentucky of killing buffaloes for their tongues was little more wasteful than the primitive white pine shingle maker's procedure. He used only a small portion of the choicest part of pine trees. The sapwood, the knots, much of the heart, and practically the whole trunk above the first 20 feet were left in the woods to rot. It was not unusual to sacrifice a 3,000-foot tree to get 1,000 shingles—throwing away fourteen-fifteenths and using one-fifteenth. The introduction of shingle-making machinery put a stop to that enormous waste, for the saws could make shingles of knots, slabs, tops, cross grains, and all else, from stump to crown. The old-style method of shingle making died hard, for the shavers opposed the introduction of machines, and declared the ruination of the country would follow so radical a revolution in a widespread industry.

It was sometimes found necessary to regulate by law the making of shingles by the old process. Thus, in 1783, an act passed by the Massachusetts Legislature provided that if a bunch of shingles fell 2 per cent short of the regulation length, the shingles should be seized and sold for the benefit of the poor. Under the old method every individual piece was counted as a shingle, and it must be approximately of the right length and width; when sawed shingles came in they might be any width, but every 4 inches made a shingle, and a piece a foot wide counted three shingles. They were packed in bunches, usually containing 250 shingles. When made by hand, two kinds were produced, known as "joint" and "lap." The latter were longer, with one edge thick, the other thin, and when nailed on the roof the edge of one lapped over the edge of another, like weatherboarding. The joint shingles were short, and were nailed edge to edge, like sawed shingles.

FURNITURE.

White pine is not usually classed as a furniture wood with oak, cherry, birch, maple, and mahogany, yet large quantities of it are made into furniture, and have been so made for 200 years. Articles of furniture wholly of this wood are now unusual, but it enters into many parts. It is often found as shelving in bookcases, cabinets, cupboards, presses, and as tops for kitchen tables. For drawing tables and boards it is still the most available wood. The cost of the

wood now excludes it from uses wherein its former cheapness placed it. The highest grade of white pine does not differ much in cost from black walnut and mahogany, though cheap grades may be had. A table of clear white pine would not fall much, if any, below the cost of one of oak.

The use of white pine in furniture making is chiefly historical. A hundred years ago it was employed for the interior of mahogany bureaus, chiffoniers, and tables. To-day a cheaper wood is used. In the pioneer days, within the pine regions, it furnished the bulk of the rural furniture material. Articles made wholly of it did not last long if they were subject to much wear or strain; but the wood was cheap, easy to work, and it was made into chairs, benches, stools, bedsteads, cupboards, presses, tables, and nearly all else that country houses contained. Oak was nearly always to be had when pine was used, and the preference given to pine was due, in most instances, to the greater ease with which it could be worked. The makers of church furniture find a number of places for white pine.

BOXES.

White pine holds its place remarkably well as a box material, in spite of the lessening supply and advancing price. It is lighter than the yellow pines and red gum, which are its hardest rivals. It nails much more easily than they, though it does not hold nails so well. Box lumber is generally of cheap grade, and second-growth pine is not excluded because of knots. In Massachusetts, in 1908, box makers used 263 million feet of second-growth pine, at an average cost at the factory of $16.85 per thousand feet. A large part of this pine was made into shoe boxes. Another large use for the wood is in the manufacture of boxes for the shipment of cloth and other merchandise from wholesalers to retailers. Shipping cases of this character are often of large size, requiring a hundred feet or more of lumber. Boxes for pianos and organs are often of white pine, and it is much in demand for fruit boxes and cases in which to pack chocolates and candies for shipment. Many tobacco cases are made of it, and it is, in fact, employed for boxes of so many kinds that particular reference to each class would be impossible. Many users of cheese boxes insist on having it, in preference to all others, because it imparts no taste. It is made into bottoms and tops, while the bent wood is ash, elm, or some other wood which is not apt to impart a taste.

COOPERAGE.

Large amounts of white pine are employed in cooperage, chiefly in what is known as straight-stave ware. That includes fish and lard buckets, washtubs, water pails, sirup buckets, keelers, piggins, churns,

and ice-cream freezers. In making fish barrels the sapling pine is used. This is a hard, tough, resinous, coarse-grained white pine, which has greater strength than the ordinary kind. Its character is supposed to be due to its place of growth on dry, elevated lands. White pine grows in various soils and situations, but the better the land the better the wood. The sapling pine is in a measure similar to the white poplar—a tough, inferior kind of yellow poplar which has grown on dry, poor land.

The cooper chooses white pine for a rather large class of domestic wares which are intended to contain articles of food. Among these are salt buckets, and small kegs or keelers to contain spice, cloves, tea, coffee, and similar commodities belonging to the pantry and kitchen.

A larger kind of cooperage calls for the same wood, and it is manufactured into silos and tanks. Some of the highest grade white pine is purchased by tank builders.

The wood is well fitted for barrel and keg heads and barrel bungs, and it serves as bottoms for bent-wood measures, and particularly as bottoms for axle-grease boxes.

FARM USES.

White pine has had and still has many uses about the farm in addition to those already enumerated. Vast quantities of it were built into fences while it was cheap and convenient. It was occasionally split for rails, though probably not often. It was not an ideal fence-post wood, because it did not last long, yet it was extensively employed for that purpose. Its chief importance in fence building was as sawed boards to be nailed to posts and as pickets for inclosing gardens and truck patches. Such a fence, under favorable conditions, would do service 15 or 20 years with slight repairs. Picket fences were formerly seen much oftener than at present, and the increased cost of white pine and yellow poplar, two excellent woods for that purpose, has doubtless had something to do with the partial disappearance of pickets around yards and gardens.

Parts of many farm machines are of white pine. For hoppers, sieve frames, parts of screens, boxes, drawers, seed holders, tool carriers, and many other portions of fanning mills, reapers, drills, tedders, thrashing machines, corn shellers, separators, and scores of other apparatus and appliances that are necessary to a modern farm it holds an important place. Its use for dairy machinery and appliances does not appear to be decreasing.

Many bee men prefer it to most other woods for hives and frames, and poultry men consider that its lightness fits it above many others as material for egg carriers, brooders, incubators, and other poultry-yard appliances.

WATER PIPES.

White pine was formerly made into mains and pipes for municipal waterworks, and some use of it for that purpose still continues. It was also employed in New England and New York mills for conducting water from ponds to forebays and wheels. The millwright constructed conduits of staves joined and banded, and forming a continuous piece without coupling—called broken-joint construction. Mains of that kind were seldom of great length, ranging from a few feet to 50 or 100.

The mains and pipes for town and city water supply were of a different kind. They were not of staves, forming a cylindrical trunk or conduit, but of logs with a hole bored lengthwise and fastened end to end with water-tight couplings. It is uncertain when pipes of that kind first came into use in the northeastern part of the United States. A few were employed at an early day, and they were doing service in many towns a century or more ago. Other woods were given a place, but in most instances where early records mention the kind of wood, it was white pine within the range of that tree, and occasionally outside of its immediate range. At Wilmington, Del., when 300 feet of pine pipe was taken up it was sound, though it had been in the ground at least 70 years, and no one knew how much longer. Pipes of the same kind were laid in the Jamaica Pond Waterworks, Boston, very early—probably about 1800—and in 1895 sections were removed in good condition, though they had been out of use many years. Pipe laid early in the century in New York and Philadelphia was undecayed after long periods of service.

When wooden pipes are kept full of water, under considerable pressure, the water fills the pores of the wood and prevents decay. To that fact is due the long service given by pipes made of woods which, in ordinary damp situations, decay in a short time. The pipes removed from the Jamaica Pond Waterworks were hardened on the outside and, when cut, the wood was fresh and bright.

About 1860 an improved method of making wooden pipe was introduced, and the product was called the "Wyckoff pipe," named from the inventor, A. Wyckoff, of Elmira, N. Y. Instead of boring the interior of a log as the ordinary auger does it, a machine was designed to take out a core. From this core a smaller was taken, and from that a still smaller, until a log was made into several pipes, ranging downward in size. The largest had an inside diameter of 17 inches and the smallest 2 inches. The waste was comparatively small. In 1905 there were 1,500 miles of such pipe in the United States, serving in municipal waterworks, manufacturing plants, and for other purposes. Michigan had more than any other State. The pipe is manufactured from a number of woods, but more white pine seems to have

been used than any other one wood. Forty-five miles of bored white-pine pipe was in service at one time in and near North Tonawanda, N. Y., with bore from 2 to 6 inches. After 17 miles of it had been 11 years in use, it was so satisfactory that 28 additional miles of the same kind were laid. The repair bill on the 17 miles for its eleventh year of service was only $7.52.

It is found advantageous to cover the outside of wooden pipe with tar and other water-proofing materials, chiefly for the protection it affords the metal bands that are wound spirally around it to give it strength; but experiments in coating the inside with water-proofing have ended disastrously. Pipes so treated have fallen to pieces from decay in a short time. That result is due to the exclusion of water from the pores of the wood by the interior coating. Considerably more water will flow through a wooden pipe than through one of iron or steel of the same size, because wood is smoother and friction less. This is true when both wooden and metal pipes are new, and the difference in favor of wood increases with age. The wooden pipe becomes smoother with usage, while iron and steel grow rough with accretions and the bore becomes smaller.

MISCELLANEOUS USES.

The facility with which white pine may be gilded fits it for picture and mirror frames. Its use for that purpose dates back more than a century.

Its use for heddles in cloth factories is a continuation of its employment for a similar purpose when nearly every country house and many in towns had looms for weaving cloth. It was the white pine's light weight that fitted it for that place, as the heddles had to be lifted or lowered for every thread that went into the woof. Its wide use for warping bars was for the same reason. That appliance, on which the thread for weaving woolen, linen, and cotton cloth was wound preparatory to putting it in the loom, was in most farm-houses at the period when weaving was done at home, but it has now practically disappeared along with its companion pieces, the rustic loom and the reel.

In the white-pine region, chiefly in the Lake States, the wood has a number of uses which are somewhat local, though of considerable importance, and are due largely to the convenience with which the wood may be had. Among such are bodies for bobsleds and sleighs. Some manufacturers prefer the wood above others for that purpose. It forms parts of windmills, beds for farm wagons, scales and appliances for weighing cattle and other live stock, vats of various kinds, sash and finish for hothouses, wood pulp, ice boxes, trunks, and spools on which to wind wire or rope.

In some of the sawmill towns of Michigan, where sawdust was superabundant, it was turned to accoount by paving streets with it, packing it down as a macadam road is built. The result was usually satisfactory.

When Minneapolis laid its white-cedar pavements it used 2-inch white-pine planking as a foundation on which to lay the blocks.

Between 1860 and 1870 Brooklyn paved some of its streets with white pine blocks which had been dipped in coal tar. They gave an average of 6 years' service. The city of Toronto laid a small amount of white-pine pavement in 1895, but found it a less satisfactory wood for that purpose than the northern white cedar.

No other wood equaling white pine has been found in this country for pattern making, though fairly satisfactory substitutes have been found in yellow poplar, redwood, and a few others. The pumpkin pine was the best, but that can no longer be had. The pattern maker wants a soft, solid material, and spongy woods and those of crooked grain and with knots will not do. Modern lumber yards supply little that meets the requirements, because old, mature trees grown in fertile soil—the kind that yielded pattern wood—are now very scarce. Pattern makers buy the frames of old mills and other buildings, erected and perhaps abandoned 20 to 40 years ago in Michigan and Wisconsin, and use the pine beams and timbers. The timbers taken from old mills and barns in northwestern Pennsylvania have been put to the same purpose.

White pine is one of the many woods manufactured into excelsior. It also furnishes a large part of the wood made into matches in this country. The quickness with which the coal dies after the blaze is extinguished is one of its principal recommendations for match making.

Its clear grain and the ease with which it may be cut makes it a favorite for scroll work and for cornice and capital decorations.

White pine is preferred to all other woods for the bodies of children's wheelbarrows and for hobbyhorses. The saving of a few ounces or pounds in weight in toys that are constantly in motion is an important consideration. The seats and other wooden parts of baby buggies and children's chairs, stools, carts, and swings are frequently of white pine.

Its softness and its light weight are properties considered in choosing it for drawing boards, cutting boards, and cloth boards, penholders, and toys of many kinds. Snow shovels, protected with metal cutting edges, are made of this wood. One of its competitors in this field is butternut, which is of nearly the same weight.

It is used in making shoe racks, a kind of truck employed in factories and large stores to carry shoes from one part of the building to another.

White-pine piano keys compete for first place with basswood. It has other uses in piano and organ making, and for some purposes is substituted for holly. It is an excellent wood for pipes in church organs, and for that purpose has been classed with the sugar pine of California and the southern white cedar of the Atlantic coast.

Golf-goods makers find it useful, though for very different purposes from those demanding hickory, ash, and elm. It goes into racket handles, where a light-weight wood is desired, and is frequently a competitor with red cedar for that purpose.

Caskets and coffins and the boxes in which they are shipped are manufactured of white pine in many instances. It is used also in making tobacco boxes and for the bottoms and sash of show cases.

BY-PRODUCTS.

Considering the great extent of the white pine forests and the important part their wood has played in the industrial development of the country, the by-products are few. As early as 1672 a law directed that the Plymouth Colony should make 10 barrels of tar a year. That quantity was very small, and probably pitch pine contributed as much as white pine. The turpentine or resin from the tree has been collected in a small way as a domestic remedy for rheumatism, ulcers, burns, frostbites, cuts, and bruises, but the medicinal value of the product is open to question. Sometimes the macerated inner bark was substituted for the resin, and a sirup made from it was believed to be efficacious in the treatment of whooping cough. A distillation from green cones was once believed effective in removing wrinkles from the skin if applied liberally as a wash. White pine sawdust is frequently employed in the manufacture of porous bricks. The dust is mixed with the clay or pulverized shale of which the bricks are made, and in the process of burning the heat destroys the sawdust and leaves the bricks porous. The conversion of white pine sawdust into gas for use in gas engines has been suggested, but no claim is made that it is better than the sawdust of California redwood or probably several other woods. The ground bark has been employed as an astringent, and the resin is recommended as an ingredient of cough sirup. In New England, and perhaps elsewhere, the shavings in planing mills are baled and sold as horse bedding in stables.

DISEASES.

The diseases and injuries to which the white pine is peculiarly liable have more to do with retarding or preventing the growth of wood than in damaging it after it has grown. Blight, either with or without fungus attack, occasionally injures growing pine in different parts of its region. The young trees have thin bark, and a

moderate forest fire damages or kills them. Wherever white pine forests have been cut fire has generally followed and killed the young pines that sprouted from seeds on the ground. The tree does not sprout from the stump, and when seed trees are removed and the seedlings already on the ground are killed by fire, as frequently happened in Michigan and elsewhere, the natural growth of pine in that district is at an end.

Direct injury to pine logs and lumber results from attacks of several insect enemies which may kill the trees or perforate the trunks of dead timber or damage sawlogs. Much injury was done from 1888 to 1893, from Maryland to North Carolina, by a bark beetle (*Dendroctonus frontalis*), but its ravages were not serious after that period. The pine sawyer—so named from the grating noise it makes as it eats its way into sawlogs—is a larva. There are several species. The white pine weevil bores the pith of twigs and makes special attacks on terminal shoots, thereby deforming young trees, which, on that account, though they may attain large size, are unfitted for high-grade lumber.

NORWAY PINE (Pinus resinosa).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.25 pounds per cubic foot (Sargent).

Specific gravity.—0.485 (Sargent).

Ash.—0.27 per cent of dry weight of wood (Sargent).

Fuel value.—65 per cent of white oak (Sargent).

Breaking strength (modulus of rupture).—10,800 pounds per square inch, or 67 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,605,000 pounds per square inch, or 76 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, not strong, moderately soft; grain rather coarse, even, and straight; compact; annual rings rather wide; summerwood not broad, light colored, resinous; resin passages few, small, not conspicuous; medullary rays few, thin; color light red, the sapwood yellow or often almost white; readily worked with tools; not durable in the soil.

Growth.—Diameter, 2 to 3 feet; height, 75 to 125 feet.

SUPPLY.

The commercial range of Norway pine lies in Michigan, Minnesota, and Wisconsin, in the United States, and in the Provinces of Canada. A small quantity is cut in New York, Pennsylvania, and New England. The tree is known also as red pine, hard pine, and Canadian red pine.

The supply of Norway pine in the United States and across the Canadian border is much smaller than formerly. No special demand has ever been made upon it, as was the case with white pine, yellow poplar, and black walnut, but it was put to some use from the first

settlement of the region. It was not found in extensive pure forests, as white pine was, and though its range covered 1,500 miles east and west and 300 or 400 north and south, the total quantity of Norway pine in the original forests was comparatively small. The supply now comes largely from Michigan, Minnesota, and Wisconsin, and Chicago is the central market. Exports which formerly found their way to England, but which are small now, went from Canada and Maine.

Norway pine grows with fair rapidity and is not exacting in its soil requirements. It insists, however, upon an abundance of light, and for that reason it is unable to force its way into areas where vigorous trees have a footing or to hold its own place successfully against trees which crowd it. This has, apparently, relegated it to poor, dry land, where competing species grow slowly or not at all. Experiments have demonstrated that Norway pine can be successfully grown in plantations. In rate of growth and form of bole it compares favorably with white pine in similar situations. It produces enormous numbers of very small seed. In spite of this fact it has not held its ground in regions where it was formerly abundant, and it is not counted upon to figure largely in the country's future supply of lumber.

The fact that Norway pine occupied the region with white pine, and was cut with it, and the lumber of the two species went to market together, and usually as one, resulted in relegating Norway pine to an obscure place far below its worth. White pine was the predominant timber of the region and attracted most of the attention of the buyers, sellers, operators, and all persons who were interested in the softwoods of the Lake States and the pine regions farther east. Nevertheless, Norway pine was an important source of timber. It was not used for all the purposes for which white pine was employed, but was for many of them. In presenting a list of its uses, the white pine list will answer with slight change, but with the provision that Norway pine fell very far below it in total quantity. In high-grade wood white pine was likewise ahead of it, but in the great middle and lower field of usefulness the two pines did service side by side.

SHIPBUILDING.

This wood has been put to use for various parts in shipbuilding in this country and in England, but the quantity used seems to have been moderate. A century ago it was much more common in the London market and in the dock yards on the west coast of England than it is now. Decking planks, occasionally 40 feet in length, were cut in Maine, Canada, or from timbers shipped across the Atlantic. Wide planks were impossible, because the Norway pine is small, and shipbuilders insisted on heart with no sapwood. This was necessary,

because the sapwood soon changed to a green color, due to fungus attack, and decay followed. The wood was used, and still is used, both in this country and in Canada and England for masts, spars, and deck plank. The wood is resinous and wears well. It has been described as midway between pitch pine and white pine. It is seen in cabins and fittings of vessels. When the Canadian French made a beginning in building a navy in the early history of that country they selected Norway pine for masts, while the forests contained practically unlimited supplies of other timbers.

The use of this timber for masts in former years when it was abundant was said to have been considerably lessened by the fact that trunks were seldom quite straight. Perfect sticks compared favorably with Danzic and Riga pine, and as late as 1875 its use in the British navy was reported.[1]

About 1895 the city of Toronto laid a number of woods in block pavement to test the lasting properties of different timbers in the untreated state. Norway pine was so used, and the results were favorable. White pine and Norway pine were rated equal—both were below northern white cedar, but above hemlock, sugar maple, beech, and slippery elm. The poorest results were shown by the elm.[2]

Pump makers drew supplies from Norway pine 100 years ago. Long, clear stock could be had without sapwood. The wood enters into car construction, including sills, frames, and the running boards on top of freight cars. It is sufficiently hard and strong for flooring, girders, joists, windmills, and bridge timbers. It makes good panels, but is occasionally objected to for doors and sash, because of its tendency to warp and twist. On account of scarcity, Norway pine has been obliged to retire from uses which it once filled, and its place has been taken by yellow pine and cypress. Norway pine has been suggested for posts, poles, and railway ties after receiving preservative treatment to hinder decay.

Makers of agricultural implements employ this pine for many parts, and it gives good service as sucker rods for windmills, and also as slats and fans and for water tanks.

BY-PRODUCTS.

The resin content of Norway pine is sufficient to attract the producer of turpentine and pine oil. At various points in Canada and in the United States distillation plants have operated on Norway pine stumps for these products. The resinous material is found principally in the lower portion of the tree; the part left in the stump is in fact richer in these materials than any other portion. Because of

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[1] Timber and Timber Trees, Thomas Laslett.

[2] Street Pavements and Paving Materials, G. W. Tillson.

this fact Norway pine stumps have resisted decay, and now, 20 years following cutting, they are in some localities being pulled up and sent to the distillation plant. On arriving there they are washed clean of dirt and gravel, and then, by means of saws, "hogs," and shredders are reduced to small particles not over one-quarter inch thick and an inch or two long. By a blower process the rotten chaff and remaining dirt are separated out. The remainder is then ready for the steaming and extraction process by which the turpentine, oils, and rosin are obtained. The fibrous material, not being destroyed, is suitable for boiler fuel after these processes are completed. It is possible even that this material may be further utilized in making pulp for fiber board.

JACK PINE (Pinus divaricata).

PHYSICAL PROPERTIES.

Weight of dry wood.—29.7 pounds per cubic foot (Sargent).

Specific gravity.—0.48 (Sargent).

Ash.—0.23 per cent of dry weight of wood (Sargent).

Fuel value.—64 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—9,100 pounds per square inch, or 57 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,332,000 pounds per square inch, or 63 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong; grain fine; annual rings moderately wide; summerwood not broad, resinous, conspicuous; resin passages few, not large; medullary rays numerous, obscure; color clear light brown or rarely orange, the thick sapwood almost white; not durable.

Growth.—Height, 50 to 65 feet; diameter, 1 to 2 feet.

SUPPLY AND USES.

Among the names by which this tree is known in different parts of its range are scrub pine, gray pine, princess pine, black-jack pine, black pine, cypress, Canada horn-cone pine, chek pine, Sir Joseph Banks pine, juniper, and Bank's air pine.

There is little probability that jack pine will ever take its place among the important timber trees of this country. Its small size alone retires it to a secondary place; yet it has and promises to have a certain value, which entitles it to consideration. The tree has attracted considerable attention from foresters, who see in it the probable means of covering large areas of sterile, waste land on which few if any other trees will grow. Its commercial range includes the northern tier of States from Maine to Minnesota and extends as far north in Canada as Hudson Bay. It has been found efficient in fixing the drifting sand in certain parts of Michigan where the original forests were cut and burned, and at the same time supplying considerable wood and lumber to the industries of the region. Jack pine

is tenacious of life and grows in the face of adverse circumstances. In can maintain itself on sand and send its roots down several feet to moisture, while it thrives on land with the water table very near the surface. It is seldom uprooted even by the most violent winds. In early life its growth is rapid, but it matures early. Its average term of life is probably not more than 60 years. In that time it attains a diameter fitting it for railway ties, and a height of perhaps 50 or 60 feet.

Lumbermen cut the jack pine to a diameter of 4 inches, and saw the logs or poles into bed slats, or staves for nail kegs, or plasterer's lath. Thousands of cords of such logs go to the factories each year and meet a demand which must otherwise be met by wood of higher grade. Barrel and keg headings are made for the slack cooperage industry, and box factories draw supplies in large quantities from this wood. The larger logs make dimension lumber, while in some localities fences, including posts and boards, are made of this wood. It is an important source of fuel in many parts of its range.

Jack pine contributes to the country's pulp supply for the manufacture of paper. The pulp mills in the Lake States have made considerable use of it for this purpose, for which it appears to have about the same value as the scrub pine of Virginia and Maryland. It is used in both the mechanical and chemical processes of manufacture.

WESTERN WHITE PINE (Pinus monticola).

PHYSICAL PROPERTIES.

Dry weight of wood.—24.3 pounds per cubic foot (Sargent).

Specific gravity.—0.39 (Sargent).

Ash.—0.23 per cent of dry weight of wood (Sargent).

Fuel value.—52 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—8,700 pounds per square inch, or 54 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,356,000 pounds per square inch, or 64 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong, but flexible, grain fine and straight; annual rings wide, summerwood thin, slightly resinous, not conspicuous; resin passages numerous, not large; medullary rays numerous, obscure; color light brown or red, the sapwood nearly white; as easily worked with tools as white pine; heartwood fairly durable in contact with the soil.

Growth.—Height, 100 to 175 feet; diameter, 2½ to 3½ feet.

SUPPLY.

Among the names by which this tree is known are silver pine, white pine, finger-cone pine, mountain pine, soft pine, little sugar pine, mountain Weymouth pine, and western white pine. The last name is most widely used, and distinguishes it from the white pine of the East. Its commercial range lies in California, Idaho, Mon-

tana, Oregon, and Washington. The largest cut is credited to Idaho, with Washington and Montana following. It grows in Oregon and California, but comparatively small quantities are cut there. It is found on the high parts of the Sierra Nevada Range, in some localities running up to altitudes of 10,000 feet or more, but the timber which grows at that altitude is not usually of a quality suitable for commercial purposes. The drain upon the forests of Idaho has increased in recent years, and in 1908 the cut of this pine exceeded the output of the year before by more than 36 million feet. Estimates of the total available supply in the United States have not been carefully made. The tree seldom grows in pure stands, though sometimes it predominates over associated species. Usually, however, it forms a low per cent of the forest in which it is found. Throughout the northern part of Idaho it makes the best growth of all species, and produces the bulk of the merchantable timber. The yield is greater also than that of any other tree. Mr. F. G. Rockwell, of the Forest Service, reports that in 1910 he found fully stocked stands of western white pine which contained over 130,000 feet b. m. per acre. The timber was all 140 years old, with an average height of 130 feet.

USES.

Western white pine is the most valuable species in Montana and Idaho. It serves fairly well as a substitute for the white pine of the east for a number of purposes. The western species is a little heavier, has a slightly higher per cent of ash, its fuel value is a little more, its strength is a little less, but in stiffness it surpasses the eastern white pine by 12 per cent. It is claimed that the eastern wood surpasses the western in durability.

The tree has been used within its range since the settlement of the region began. Trunks of large size in Idaho were occasionally made into split shakes or clapboards for roofing cabins and barns, but the wood was not liked as well for that purpose as cedar, and was pressed into use only when cedar was not to be had.

Considerable quantities of western white pine have been employed for mine timbers in that region, and in some localities it served as fence material in building stock corrals and in inclosing pastures and grain fields. Miners make use of it for stulls, lagging, flumes, water tanks, sluice boxes, water pipes, rifle blocks, rockers, and guides for stamp mills, for some of these purposes giving it preference over other timbers. The chief demands for it, however, are in distant markets, and comparatively small amounts are used in the region of production. It is a substitute for the white pine, and for that reason it seeks markets which the white pine of the East formerly held. It is bought by planing mills and manufacturing establish-

ments in the Mississippi Valley, and further East, for all classes of planing-mill stock, including flooring, ceiling, finish, siding, sheathing, shelving, doors, sashes, panels, columns, lattice, pantry work, and a long list of other forms. It is claimed that in some instances sash factories buy rough lumber in the Rocky Mountain region, have it shipped to Chicago or some other manufacturing center, make windows of it, and sell them in the region, perhaps the very town, whence the rough lumber came. This is made possible by the fact that glass is manufactured in the East, and the large sash factories locate near the glass supply. In some instances, but less frequently than in the case of sash, western white pine doors are made in distant cities and are shipped to the Rocky Mountain region to be sold near where the wood grew.

In the region where this white pine grows in proximity to merchantable Douglas fir and western yellow pine, it finds few buyers, because the other woods undersell it. In some instances the fir and yellow pine shipped to the Rocky Mountains from farther west are sold at a lower price than the white pine, and have crowded the latter out of its home market. It finds sale, however, farther east, where its chief competitor is the white pine cut in the Lake States. Thus the spectacle is presented of Pacific coast lumber entering the Rocky Mountain region and driving a native lumber from that market, and the displaced commodity, in its turn, competing successfully in the eastern market with a splendid wood of the East.

The western white pine has a wide market, won and held on its merit. It is shipped as far east as Boston, is in demand south of the Ohio River, enters the principal markets of the Central States, and is used for orange boxes in California, though the amount so used is not large. A considerable quantity of it has been exported to Australia. The total yearly output of western white pine lumber probably exceeds 150,000,000 board feet. Much of it goes into rough construction, but a large amount is used for other purposes. Factories making window blinds and shutters use this wood because of its light weight and its comparative freedom from resin, decay, and other defects. It finishes nicely and paints well. The same qualities recommend it for doors, window frames, and finish, both inside and out. It has been pronounced as good for picture frames, cabinet work, veneer backing, pyrography, baskets, and all classes of woodenware, and other plain and ornamental molding as the eastern white pine. It finds a place in undertaking establishments in the manufacture of burial boxes, in which the casket or coffin is placed. It has some use for shipping boxes for fruit and merchandise, but such use has not yet become important, because in the fruit-growing sections of the regions where this tree grows, as well as farther east, other woods are cheaper. Conditions very similar lessen its use for large packing

boxes in the manufacturing districts of the East. Cheaper woods grown near by supply the boxes in which merchandise is sent to market.

Pattern makers have drawn suitable material for their wares from western white pine. It meets the requirements fairly well, being soft, light, and easily cut across the grain as well as with it; but it is not usually considered the equal of the white pine of the East for this purpose, nor has it been able to compete as a pattern wood in the Pacific coast region with redwood, sugar pine, and western red cedar.

WESTERN YELLOW PINE (Pinus ponderosa).

PHYSICAL PROPERTIES.

Weight of dry wood.—29.4 pounds per cubic foot (Sargent).

Specific gravity.—0.47 (Sargent).

Fuel value.—63 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,100 pounds per square inch, or 63 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,209,000 pounds per square inch, or 57 per cent that of longleaf pine (Sargent).

Character and qualities.—Rather light, not strong, grain fine, even, often twisted; annual rings variable in width, summerwood broad or narrow, resinous; resin passages medium and rather numerous; medullary rays not numerous, prominent; color light to reddish, thick sapwood almost white; not durable in untreated condition, but readily receives treatment.

Growth.—Height, 100 to 200 feet; diameter, 3 to 7 feet.

SUPPLY.

The total stand of western yellow pine in the United States in 1909 has been estimated at 275 billion feet b. m. Douglas fir was the only species showing a greater total, and the southern longleaf pine was next below. The four southern yellow pines together were estimated at 110 billion feet more than western yellow pine. White pine and Norway pine together amounted to only one-fourth the quantity of this western timber. In amount it is more than half the estimated combined stumpage of all the hardwoods in the United States.[1]

Few trees have a commercial range as wide as that of the western yellow pine. It has its best development on the Pacific coast, but it covers one-third of the United States. It is cut in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming, and is found to a smaller extent over a considerably wider area. In 1908 the largest output was in California, followed by Oregon and Montana in the order named. It is not always possible to separate the cut of this species from other pines of the region, because in many cases they are

[1] Forest Service Circular 166, The Timber Supply of the United States; also report of the Bureau of Corporations on the Lumber Industry, 1911.

reported as one. The tree has a number of names by which it is known in different localities, among them bull pine, big pine, long-leaved pine, red pine, pitch pine, heavy wooded pine, western pitch pine, heavy pine, foothills yellow pine, Sierra brown bark pine, Montana black pine, and California white pine. Some of these names are also applied to entirely different pines. Occupying as it does a range so extensive, with climates and soils differing, the western yellow pine does not present the same appearance and the same characteristics everywhere.

The enormous total supply of western yellow pine is not the only factor in its importance. It is practically the only timber in extensive regions, where its value can scarcely be overestimated. Next to incense cedar and the big tree, it is the most prolific seed bearer of the western conifers, and its seeds are sufficiently light to insure their wide distribution. This is one of the factors which gives the species its power to reproduce in the face of obstacles which stunt or kill some of the trees associated with it. The species is gaining ground within its range. It takes possession of vacant areas which have been bared by lumbering, fire, or other cause, and is usually able to hold its ground. In some cases it crowds out and kills the more stately sugar pine, because the latter succumbs more readily if its supply of light is seriously interfered with. It resists fire better than most of the forest trees with which it is associated, and this gives it a decided advantage. On the other hand, it suffers from insect enemies more than its associates, and in some localities this is a serious drawback. A beetle (*Dendroctonus ponderosæ*) sometimes destroys large stands. An estimate made in 1903 placed the beetle-killed timber in the Black Hills, S. Dak., at 600 million feet. That was twenty times the amount of this species cut in South Dakota in 1908. The enormous numbers of these beetles may be judged from the fact that 10,000 have been found in a single tree 8 inches in diameter, while a tree 30 inches in diameter has been estimated to contain 200,000.

The wood of the beetle-killed timber turns blue, owing to the presence of a fungus that enters through the holes made by the beetles. The bluing commences in the immediate vicinity of the holes and spreads rapidly through the wood, which is not damaged immediately, except that its color is objectionable, but decay is liable to follow the bluing. This pine occasionally suffers from the attacks of two other beetles, and much of the stand in small areas is killed. These are the mountain pine beetle (*Dendroctonus monticolæ*) and the western pine beetle (*Dendroctonus brevicornis*). A fungus called red rot sometimes does considerable damage to standing timber.

EARLY USES.

The western yellow pine was one of the earliest woods of the far West to be employed as mine props, and in many localities met the whole demand. The timber was sufficiently strong for the purpose, and the supply was usually abundant. Quartz mills for crushing the ores accompanied the underground mining operations, and in most cases steam engines furnished the power. The fuel was wood cut from the surrounding hills and canyons, and this pine supplied a large part of it. A single mine sometimes stripped hundreds of acres for fuel and props.

This timber performed an important part in railroad building on the western mountains and plateaus. The procuring of ties and bridge and trestle timbers was frequently one of the most difficult problems to be solved by the engineers. The forests of western yellow pine were drawn upon in many places where no other wood was available. In 1869, when the Kansas & Pacific Railroad was building, yellow-pine ties and bridge timbers were cut in Colorado and hauled by teams long distances eastward into Kansas. The Colorado Southern Railroad and the Denver & Rio Grande were built to a large extent with yellow-pine ties cut in Colorado.

Western yellow pine is coming into use among the electrical companies of southern California for telephone poles. The wood, which is sufficiently strong, had been ruled out in the past on the ground of insufficient durability. Methods of treating the butts of the poles with preservatives have been developed which are doing away with this difficulty. There are numerous stands of young timber throughout the range of the tree which are of just the right size for pole purposes.

During the Civil War the turpentine supply from the South was cut off, and the extraordinary demand for it and the high price stimulated the industry wherever yellow pine could be found in sufficient quantity. The extensive yellow-pine forests on the sides and summits of the Sierra Nevada Mountains, in Butte and Tehama Counties, Cal., were boxed and the business was profitable for a time. After the close of the war the southern forests became available and the Sierra Nevada pineries were abandoned by turpentine gatherers. The boxing caused great injury to the trees, and 40 years afterwards the trunks had not recovered.

MANUFACTURE AND PRODUCTS.

Westerr yellow pine has uses ranging from the coarsest construction to highly finished products. House frames, beams, joists, rafters, sills, sheathing, and studding are cut in all workable dimensions. It

is heavier and stronger than eastern white pine or the sugar pine of the far West. In some respects, chiefly in appearance, its wood bears considerable resemblance to both. The building of flumes to lead water along the faces of steep mountains and across sandy tracts, for floating timber, operating mines, and for irrigation, calls for very large quantities of wood, and yellow pine meets much of the demand. It frequently grows in the regions where the flumes are built, and for that reason it is the cheapest and most convenient material available.

It fills an important place as a fencing material, being occasionally but not frequently used for posts, and more often as boards and pickets. It gives good service as bridge timbers, and in many regions it is the best obtainable for bridge floors, though for this purpose it is inferior to nearly all species of oak and to Douglas fir and western hemlock. It furnishes sidewalks in many towns where wood is the only available material. As plasterer's lath it meets a large demand. In some regions, especially in Colorado, it is made into shingles.

This pine loses 2,000 pounds in weight per 1,000 feet b. m. in the process of seasoning. The lumber is widely exported, and reaches New Zealand, Australia, England, Ireland, Scotland, the Continent of Europe, and elsewhere.

Some of the finished products of the wood, notably sashes and blinds, are sold both at home and abroad as white pine. Planing mills that manufacture flooring and ceiling obtain some of their best lumber from western yellow-pine yards. It is often known as California white pine, and is made into several kinds of interior finish, molding, spindles, balusters, railing, panels, newels, brackets, chair boards, and frames. The wood is now shipped as far east as Wisconsin to be made into these products. It is one of the woods employed by pattern makers, though it is not generally considered equal to white pine for that purpose.

The match factories draw some of their supplies from this wood in northern California.

It is an important box material on the Pacific coast, and is widely used in packing establishments as far east as the Mississippi. It competes successfully with sugar pine and western white pine for boxes in which to ship fruit. Large quantities of lemons, oranges, apples, peaches, raisins, prunes, cherries, and other products of the orchards and vineyards of the far West and the Rocky Mountain region reach the consumer in boxes of this pine.

Slack coopers employ it in manufacturing buckets, kegs, and barrels for shipping vegetables and fruits, and it is also used for barrels to contain certain fluids, but not for alcoholic liquors.

SUGAR PINE (Pinus lambertiana).

PHYSICAL PROPERTIES.

Dry weight of wood.—23.0 pounds per cubic foot (Sargent).

Specific gravity.—0.37 (Sargent).

Ash.—0.22 per cent of dry weight of wood (Sargent).

Fuel value.—49 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—8,400 pounds per square inch, or 52 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,096,000 pounds per square inch, or 52 per cent that of longleaf pine (Sargent).

Character and qualities.—Very light, soft, not strong; grain coarse and straight; growth rings wide; summerwood thin, resinous, conspicuous; resin passages numerous, very large; medullary rays numerous, obscure; color light brown, sapwood nearly white; easily worked with tools.

Growth.—Height, 150 to 275 feet; diameter, 5 to 10 feet.

SUPPLY.

The botanical range of sugar pine extends from southern Oregon to Lower California in a comparatively narrow strip about 1,000 miles long. This pine is known also as big pine, shade pine, great sugar pine, gigantic pine, and purple-coned sugar pine. The tree is not cut for lumber in any considerable amount in more than half its range. In Oregon[1] it has been cut for lumber during 50 years, but the bulk of the output has been in California. In 1900 the cut was about 52,000,000 feet; in 1904 it was placed at 120,000,000; in 1907, at 115,000,000; and in 1908, at about 100,000,000. In the last year named Oregon supplied 7 per cent of the total. Practically the entire California output comes from the Sierra Nevada Mountains, and is cut in regions where the annual precipitation is 40 inches or more. The sugar pine thrives best on well-drained ridges and flats when the rainfall is plentiful. In Oregon its range comes down within 1,000 feet of sea level; but the limit gradually rises toward the south along the Sierra Nevada Mountains, until southern California is reached, where not much of the timber is found below an altitude of 8,000 to 10,000 feet.

It is difficult to estimate the total stand of sugar pine, since it never forms pure forests. It is regarded about the average if it constitutes 25 per cent of the growth in any region. The stand in California and Oregon has been estimated at from 25 to 30 billion feet.

[1] The discovery of the sugar pine affords the same interest to the botanist that the discovery of the planet Neptune presents to the astronomer—both were discovered before they were seen. David Douglas found seeds in the pocket of an Indian in Oregon nearly 100 years ago and at once saw that they belonged to an unknown tree. Following the directions given by Indians, he traveled many miles over mountains and valleys and was rewarded by discovering the largest pine in the world. He measured a fallen trunk that had been 245 feet high and 18 feet in diameter 3 feet from the ground.

The authors have been unable to learn of any trees observed in recent years which were anything near the size of that reported by Douglas.

If that turns out to be correct, it would supply for 250 years the output at the present rate. Those, however, who have witnessed the cutting of sugar pine during the past 20 or 30 years express doubts as to the continuance of the supply far into the future.

Sugar pine does not reproduce with vigor. The yellow pine (*Pinus ponderosa*), with which it is associated throughout nearly all of its range, is often able to crowd it out in clean cuttings, or in other places where young growth is taking the place of the old. The sugar pine's seeds ripen the second year, and the cones, which sometimes exceed 20 inches in length, fall the third year or later. The short wing with which the seed is equipped is too small to carry the burden far, and a sugar pine seldom scatters its seeds more than 200 feet. The failure of the sugar pine to reproduce is no doubt often due to squirrels, since in average years they consume most of the seeds, leaving few to germinate. The young trees endure considerable shade, which makes it possible for them to get a start when mixed with other species; but as they attain greater size they become intolerant, demand much light, and decline in growth if they do not receive it. Mature trees have a long, smooth trunk, with comparatively little taper and from which a high percentage of clear lumber may be cut. Young trees are liable to be injured or killed if they pass through a forest fire, but older timber is protected by its thick bark. Repeated fires, however, ultimately injure the trunks. Occasionally 5 or 10 per cent of a tree is wasted on account of a fire-hollowed butt.

Few sugar pines are uprooted by the wind, and the tree is comparatively free from attack by fungus. Very small trees occasionally suffer from mistletoe (*Arceuthobium occidentale*). The tree attains large size; specimens have been reported 20 feet in diameter and 300 feet high, but a sugar pine 10 feet in diameter is seldom seen even in forests that have never been culled, and a height of 250 feet is rare.

EARLY USES.

The use of sugar pine in California began soon after the discovery of gold. The early stockmen and ranchers did not draw much upon the mountain forests, for the double reason that they used little lumber upon their fenceless domain and that few roads then led into the mountains. Sugar pine grew well back in the ranges and was inconvenient if not inaccessible. The rapid increase of population following the discovery of gold called for buildings, and roof material was in demand. In California there were only two woods which answered the latter purpose well—redwood and sugar pine. The two timbers grew in widely separated regions, the redwood along the northwestern coast and the sugar pine on the mountains from 100 to 200 miles inland. The region near enough to the redwoods to draw supplies from them without railroads was beyond the reach of sugar pine;

while the people who could procure the pine were too far away from the redwood to make much use of it. For that reason there was not much competition between the two woods. Sugar pine roofed the shacks in a region 500 miles long.

The making of shakes became an important occupation on the Pacific coast. The shake is a split, unshaved shingle, usually 30 inches long and from 4 to 6 inches wide, and seldom more than half and often only a quarter of an inch thick. Thinness was regarded as a virtue rather than a fault so long as the shake had enough body to keep out the water. In early days the shake maker bought no timber, but took it without leave or license from Government land. The shake maker was wasteful. Under the most favorable circumstances the timber felled was seldom half used, and often after trees that would saw 10,000 or 20,000 feet of lumber were cut down they were left to rot in the woods because their splitting properties were poor. The men who worked at this occupation usually went in parties of two or four, made a camp in the pineries, and spent the summer within a radius of 200 or 300 yards. Four or five good trees afforded a season's work.

As the settlements increased in the valleys within 40 or 50 miles from the pineries, demand grew for lumber other than shakes. Primitive sheds and shanties could be made of shakes, including sides and roofs, with the earth for a floor, but more pretentious barns and residences demanded lumber, and early in California history the sawmill made its appearance. It did not, however, displace the shake maker, for he continued to provide roofing, and shakes served to cover substantial buildings on ranches and to some extent in the towns. But the shake makers were among the first to be singled out by the Government for the unlawful cutting of its timber, and the seizure of shakes representing a summer's work was not unusual. This discouraged those who were illegally cutting timber, and the maker of shakes lost half his foothold. Shake making from sugar pine, however, is still going on to some extent.

MANUFACTURE AND PRODUCTS.

Sawmills and other manufacturing machinery were early brought into use in the California sugar-pine regions. Some of the earliest sawmills did not cut sugar pine, but within four or five years after gold was discovered steam mills were located in the sugar-pine belt and were sawing lumber for flumes, sluice boxes, bridges, houses, barns, fences, and for other purposes. The quantity of lumber demanded by mines was very small compared with ranch and town demands. The pioneer millmen followed the example of the pioneer shake makers and cut convenient timber without obtaining the Government's consent. It would have been difficult at that time, however,

to obtain permission from anyone in authority, for the mountain lands, where the sugar pine grew, had not been surveyed.

More sugar pine was cut in that way in the Sierras than of all other woods combined, for it was lighter and softer than the yellow pine and better than the fir. Another species drawn upon largely, under the assumption that the Government would not protest, was the incense cedar for fence posts. The value of those two woods—pine and cedar—in the development of the region within reach of the Sierra timber belt can scarcely be estimated. Teams toiled up the steep grades to altitudes of from 4,000 to 6,000 feet, and hauled the fencing and building material from the mountain mills to the valleys below, often to a distance of 40, 50, and even 100 miles. That was before railroads brought in lumber from other regions.

Shingle mills quickly followed sawmills to the sugar pine forests, and shakes gave place to shingles on the better class of buildings. As the fruit industry began to develop, producing raisins and oranges, the box factory came to meet the new demand. At first, while good timber was plentiful and cheap, the box maker used all grades, but preferred the best; but later the price went up on the good grades, and the makers of boxes drew more largely upon lower grades. Some of the factories located in the timber belt and cut all kinds and all grades, manufacturing from the stump. Others bought cheap lumber from sawmills and carried on no logging operations. Sugar pine is a favorite wood for raisin boxes, not only because it is handsome and light, but because it imparts no taste or odor to articles packed in it. Some mills make a specialty of raisin boxes; others work their entire output into raisin trays—little portable platforms weighing a pound or more—on which the grapes are sun dried in the vineyards where they grow.

Sugar pine is a substitute for the eastern white pine for many purposes. The two woods are much alike in appearance and properties. White pine has about the same weight per cubic foot, has a slightly higher fuel value and considerably more elasticity, and is lower in ash. The lists of uses are much the same, but the amount of white pine manufactured in 1908 was thirty-three times that of sugar pine. The latter wood is shipped into the white pine region, where it sells at about the same price as white pine. It enters all the leading markets of New England and the Middle States.

Pattern makers still place white pine above all other woods in their business, but sugar pine is a close second, and some would make it equal. Large quantities of sugar pine are made into matches in California, and it serves the slack cooperage makers well, and also the manufacturers of woodenware. It has a place in boat building, largely for decking. Planing mills work it into molding, panels, posts, railing, and other interior finish, as well as blinds, sash, doors,

frames, and stair work. It is made into carvers' and cutters' boards, wash trays, and bakers' troughs. Its freedom from odor fits it for druggists' drawers and for the compartments in which grocers keep spice, coffee, tea, rice, and other provisions. The wood's straight grain qualifies it for service as pipes in church organs. Comparatively few woods are satisfactory for this purpose. Among the others are white pine and white cedar.

The claim has been made for sugar pine that it is preferable to white pine for doors and sliding sash because it shrinks and swells less, and holds its shape better. Boat builders hold that its behavior in salt water is equal to that of the best woods.

This tree is named from a product resembling sugar that forms where trunks have been injured by fire or otherwise. The principle is known as "pinite," and has been called "American false manna." It is believed to possess medicinal value. The claim that it is used to any large extent as a substitute for sugar is not well founded, since it possesses properties unfitting it for such use.

The seeds of sugar pine are about the size of peas, and are said to be the finest in flavor of all edible pine nuts. Their small size and their comparative scarcity make the gathering of them too tedious for anyone whose time is valuable, though Indians sometimes do it. The Douglas squirrel, however, is the greatest gatherer of sugar pine seeds, and in some localities his industry leaves few for other uses.

LODGEPOLE PINE (Pinus contorta).

PHYSICAL PROPERTIES.

Weight of dry wood.—25.5 pounds per cubic foot (Sargent).

Specific gravity.—0.41 (Sargent).

Ash.—0.32 per cent of dry weight of wood (Sargent).

Fuel value.—55 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—7,890 pounds per square inch, or 49 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,099,000 pounds per square inch, or 52 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong; grain fine, usually straight but sometimes twisted, annual rings usually narrow on account of the slow growth; summerwood narrow, not conspicuous, resin passages few, not large; medullary rays prominent, broad, numerous; color light yellow or nearly white, the thick sapwood often indistinguishable; easily worked because of evenness of texture, but too knotty to afford a large percentage of clear wood; not durable but readily receives preservative treatment.

Growth.—Height, 50 to 100 feet; diameter, 1½ to 3 feet.

SUPPLY.

The commercial range of lodgepole pine covers parts of Alaska, Arizona, British Columbia, California, Colorado, Idaho, Montana,

Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. In different parts of its range it is known as tamarack, prickly pine, white pine, black pine, spruce pine, tamarack pine, and Murray pine.

This tree's wide geographical range, covering a million square miles or more, and its persistence in spite of repeated forest fires, make it an important factor in the present and future timber supply. It is not, however, in the first class as a producer of lumber, and probably never will be. It is of very slow growth, and usually a century or more is required to produce a trunk large enough for a saw log. Its chief value probably will be found in its ability to supply crossties, fence posts, mine props, telephone poles, and similar small timbers. The growth in its extensive range is by no means uniform, but is thick in some districts and very scattering in others.

Lodgepole pine profits by forest fires, even though its thin bark affords so little protection against heat that a moderate fire passing through a forest of this species frequently makes a clean sweep of all the timber. But nature has provided this tree with the means of perpetuating its species in spite of fire; in fact, the very fire that kills a lodgepole pine forest is a powerful agent in causing a new growth to spring up and take the place of the old.[1] The tree is a prolific seeder. It begins to produce fertile seeds when less than 10 years old and it continues to do so for two or three centuries, provided it is not killed in the meantime by fire.

The cones hang on the trees many years; the scales are sealed together with resin and the seeds are usually unable to escape. Fire softens the resin and the seeds fall out. They are not easily damaged by heat, though the cones may be severely singed, and the scorched cones hang on the fire-killed trees until the seeds have time to fall upon the mineral soil left bare by the fire. The following spring numerous seedlings cover the ground—as many as 138,000 having been estimated for a single acre. More than 17,000, 3 feet high, have been counted on a single acre. All of them can not grow to maturity, but after 80 or 90 per cent have been crowded to death the survivors still make a thick stand of tall, slender poles. They grow slowly to trees, and under favorable circumstances the best of them finally make saw logs. Nearly or all of the pure lodgepole pine stands occupy old burns. The tree reproduces to a small extent on unburned soil, but it can barely hold its own there.

The belief that the cones never open except after a fire is erroneous, but they open slowly and during several years, and when the seeds fall they are nearly all picked up by squirrels and birds. A forest fire assists reproduction in another way than by baring the vegetable soil and showering seeds upon it—it destroys the rodents,

[1] The Life History of Lodgepole Burn Forests, Forest Service Bulletin 79.

and removes the hiding places of birds which, in an uninjured forest, eat the seeds.

The lodgepole forest attains its greatest commercial value in from 100 to 150 years. There are more young stands than old, for the tree is gaining a foothold in many localities where it once was not plentiful.

The Government's estimate of the stand of lodgepole pine in the United States in 1909 placed it at 90 billion feet.[1] That made it seventh in quantity among the important timber trees, those above it being Douglas fir, the southern yellow pines, western yellow pine, redwood, western hemlock, and western red cedar. This shows that lodgepole pine occupies no minor position in this country's timber supply. It is ahead of white pine, hemlock, cypress, both the eastern and western spruce, and dozens of other woods which have long occupied important places in the lumber market.

WIGWAM POLES.

The Indians built their lodges or wigwams of poles set in a circle and bent inward, and tied together at the top, hence the name " lodgepole." The poles were from 10 to 15 feet long, and skins were spread over them for a roof and wall. No wood was better adapted to this purpose than the lodgepole pine, and to that fact the name is due. The Indians who lived within the tree's range, and also those upon the plains within a hundred miles or so, used lodgepole poles for wigwam supports. It was customary to cut and peel a supply in the spring when the tribe set out upon its summer hunt, and leave them to season until fall. They were then light, and were easily carried or dragged by squaws or dogs to the place selected for the winter camp. Poles of nearly the same thickness their whole length were abundant, and when dry were very light. A pole 2 inches in diameter and 15 feet long weighs only 7 or 8 pounds. Because of lightness, stiffness, and strength, the poles were employed in making the only land vehicle used by Indians in that region, a sort of sled. Two poles were tied together at one end and fastened to a dog's or horse's back, and the other ends trailed on the ground. The load was fastened on the poles and was half carried, half dragged.

EARLY USES.

The tall, slender poles and trunks in a lodgepole forest served the early white settlers as well as they had served the wandering Indians. One of the first things to be provided in establishing a ranch in the far West in the early days was a corral or yard in which to confine horses, cattle, and other stock. Lodgepole pine, when it could

[1] Forest Service Circular 166.

be had, was ideal timber for that purpose. Splitting was not necessary, for poles of suitable size were abundant. It would have been difficult to split the timber, for the multitudes of small knots pin the wood together like so many nails. The frontiersman built his fences and his sheds, stables, and sometimes his cabin of this wood. If it could be had at all it was usually plentiful, and many of the early settlers from the Rocky Mountains to the Pacific made their start in the new country by drawing liberally upon the lodgepole forests for ranch timbers and for fuel. This was especially the case in the stock districts among the mountains, for lodgepole pine is a mountain tree. In the valleys and near the base of the hills other species, such as willow, cottonwood, alder, and western yellow pine were more convenient.

MINE TIMBERS AND FENCE POSTS.

The early miners made large use of lodgepole pine timbers in their operations. As mine props it was cheap, substantial, and convenient. It is the chief timber employed for props, lagging, shafts, and stulls in Colorado, New Mexico, Montana, and Wyoming. The Rocky Mountain region contains many great forests of trees large enough for flumes and sluice boxes. However, the chief difficulty in cutting lodgepole for mine purposes is the large proportion of pieces too small for use. This is not so much the case where green timber is cut, for there the small trees may be left. A large proportion of this wood for mining purposes, however, is now cut from stands killed by fire from 10 to 25 years ago. In these operations only timber large enough for mine use is taken, while much that would ordinarily serve well for fence posts is left in the woods.

The National Forests contain much fire-killed lodgepole pine. In seeking to dispose of it the Government has tested its qualities in numerous ways, and it has been shown that the strength of the timber is not impaired as long as it remains sound, which may be for many years. The wood is so thoroughly dried out that it is in excellent condition for receiving preservative treatment. This opens a field for it for telephone poles and fence posts. The butts can be treated, and durable poles and posts made of what otherwise would be a comparatively quick-decaying timber. Since these products are required in great quantities in the Rocky Mountain region, a considerable market for the fire-killed poles has already appeared.

MANUFACTURE AND PRODUCTS.

Lodgepole pine is not listed separately in statistics of lumber cut, and it is not possible to determine what the annual cut is. It is known, however, that much lumber is sawed from this species in the Rocky Mountain region, particularly in Colorado, Wyoming, Montana, and Idaho. Its chief market is the newly established agricul-

tural communities of those States. Settlements have progressed rapidly in this region since 1900, and the demand has been correspondingly strong.

The need for fruit boxes in the young orchard of the western mountain region has opened a market for this lumber; and some of it is sold to manufacturers as far east as Chicago, who make boxes of it for shipping merchandise of various kinds.

Some of the lumber is shipped from the mills under the name of western white pine, and is used for interior finish. Its color and grain fit it for that purpose, but it is at somewhat of a disadvantage on account of the numerous small knots it contains. It gives good service in rough construction and for lath. Few western woods are better for pickets and fencing plank, and much of it is used that way.

Half a million lodgepole pine cross-ties are bought annually by railroads. This number is small in comparison with the total for the country, and the number has somewhat decreased since 1907. Conditions indicate an increase, however, before long, and the importance of this wood lies more in prospective than in present use. It is a wood which yields readily to preservative treatment, and when so treated it lasts many years. A number of railroads list it among woods for treatment and have drawn upon the supply for a long time. Forty years ago great numbers of lodgepole pine ties were cut in Wyoming. The western forests are adequate to meet very heavy demands for ties of this timber, and are so situated as to make the supply convenient by flume to a large mileage of railroad.

Preservative treatment promises greatly to extend the use of this wood for fence posts and telephone poles. In its natural state it is not enduring. But well-treated lodgepole posts are good for many years—perhaps as many as 20—and this will make them the equal of cedar. The wood lasts well above ground, and in some localities is used for fences that are supported on the surface of the ground by props, instead of being set in it. The long, slender poles that grow in dense forests of lodgepole are of convenient size for posts. Preservative treatment promises a greatly extended use of this timber for mine props also.

In Colorado and Wyoming much lodgepole pine was at one time made into charcoal for the smelters, but it is in less demand now, because the building of railroads has made coal and coke available.

JEFFREY PINE (Pinus jeffreyi).

PHYSICAL PROPERTIES.

Weight of dry wood.—32.4 pounds per cubic foot (Sargent).
Specific gravity.—0.52 (Sargent).
Ash.—0.26 per cent of weight of dry wood (Sargent).
Fuel value.—68 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,400 pounds per square inch, or 64 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,327,000 pounds per square inch, or 63 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood rather light, hard, brittle, wide-ringed, compact; summerwood narrow, very resinous, conspicuous; resin passages few, not large; medullary rays numerous, obscure; wood straw-colored, the sapwood pale yellow or nearly white.

Growth.—Height of 150 feet and a diameter of 25 inches are not unusual, while trees much larger are occasionally seen. On high mountains the average height is less than 100 feet, and the diameter less than 2 feet.

SUPPLY.

This tree's commercial range lies almost entirely in California and is confined to the higher Sierras, though it is found in southern Oregon and in the northern part of Lower California. It bears close resemblance to the western yellow pine, and over much of its range is associated with it, but extends higher on the mountains. It approaches within 3,600 feet of sea level and extends, in the south, 10,000 feet above. It is known by a number of names, some of which seem arbitrary or applicable to a restricted locality. Among them are peninsula pine, Truckee pine, pinos, black pine, black bark pine, sapwood pine, Sierra redbark, western black pine, and bull pine.

It would be difficult to make an approximate estimate of stand. Jeffrey pine is not scarce within its range, which extends 1,000 miles north and south and from 20 to 150 east and west. In many localities it passes for the western yellow pine, and in timber deals and lumber operations it is frequently cut, bought, and sold as such. Botanists, however, clearly distinguish between the two. The blacker and more deeply furrowed bark of the Jeffrey pine is the usual character by which lumbermen tell them apart.

Jeffrey pine is not aggressive in extending its range or increasing its stand. Its seeds have little wing area and never fly far. Neither are they abundant, and they are at still further disadvantage by being preyed upon by birds and rodents. The tree seems to be holding its own, but no more. Better protection against fire may help it to some extent.

USES.

A review of the uses of Jeffrey pine must be made under difficulty similar to a review of the uses of the Norway pine of the Lake States. The Norway pine is cut, milled, sold, and used with white pine, frequently without effort to distinguish it. The Jeffrey pine occupies precisely similar relations to the western yellow pine. There is, nevertheless, considerable difference between the woods of the two species. The wood is harder and coarser than yellow pine, and is more likely to warp if air-dried. It would be much more valuable for fuel than it is

at present if a market for it were within reach. It is full of pitch and burns quickly and brightly, but the range of the tree lies, for the most part, remote from towns and factories, and it furnishes comparatively little cordwood. A small quantity was formerly cut for poles on the margins of elevated glades and natural meadows of the Sierras, and was used for fencing corrals; but it was not liked for this use as well as the lodgepole pine, which very often could be had with no more labor.

ARIZONA LONGLEAF PINE (Pinus mayriana).

This tree's range lies in southern Arizona and New Mexico, and it thrives at lower altitudes than the western yellow pine. It occupies dry situations, and the trees are usually of less height and diameter than the yellow pine, but the woods of the two species are much alike. They are sawed, sold, and used without distinction.

CHIHUAHUA PINE (Pinus chihuahuana).

PHYSICAL PROPERTIES.

Weight of dry wood.—34.0 pounds per cubic foot (Sargent).

Specific gravity.—0.55 (Sargent).

Ash.—0.39 per cent of weight of dry wood (Sargent).

Fuel value.—72 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—11,600 pounds per square inch, or 72 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,048,000 pounds per square inch, or 49 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, rather strong, brittle, narrow-ringed compact; summerwood not broad, resinous, conspicuous; resin passages few, rather large, conspicuous; medullary rays numerous, thin; color clear light orange, the thick sapwood lighter.

Growth.—Height, 50 to 80 feet; diameter, 15 to 20 inches.

The Chihuahua pine is found in commercial quantity, though not in abundance, in southwestern New Mexico and southern Arizona. Although the logs average rather small for profitable lumbering, such lumber as is cut ranks with western yellow pine and is used for similar purposes. In addition to this, it has considerable local value as fuel and is employed about ranches for posts, sheds, and other timbers. It occasionally finds employment as posts, props, and lagging in mines. Estimates of stumpage for this species have not been made, but the supply is not large. The tree reaches its typical development at altitudes of from 5,000 to 7,000 feet above sea level.

APACHE PINE (Pinus apacheca).

This tree so closely resembles the western yellow pine in the region where both occur that some are inclined to consider it a form of that species. It is found in southeastern Arizona and is best developed and most abundant in the Chiricahua Mountains. So far as it is put to use, it passes for yellow pine.

ARIZONA PINE (Pinus arizonica).

PHYSICAL PROPERTIES.

Weight of dry wood.—31.4 pounds per cubic foot (Sargent).
Specific gravity.—0.5 (Sargent).
Ash.—0.2 per cent of weight of dry wood (Sargent).
Fuel value.—68 per cent that of white oak (Sargent).
Breaking strength (modulus of rupture).—9,100 pounds per square inch, or 57 per cent that of long-leaf pine (Sargent).
Factor of stiffness (modulus of elasticity).—1,153,000 pounds per square inch, or 54 per cent that of longleaf pine (Sargent).
Character and qualities.—Light, soft, not strong, rather brittle, compact; summerwood broad, very resinous, conspicuous; resin passages numerous, large; medullary rays thin, obscure; color light red, or often yellow, the sapwood lighter yellow or white.
Growth.—Height, 75 to 90 feet; diameter, 18 to 30 inches.

SUPPLY AND USES.

The range of the Arizona pine is restricted to the mountains of southern Arizona, where it attains its best development on rocky ridges from 6,000 to 8,000 feet above sea level. It is the prevailing forest tree near the summit of the Santa Catalina Mountains. In general appearance it closely resembles the western yellow pine, and the two species are frequently cut, milled, and sold in that region without distinction; but this holds only for the better grades of Arizona pine logs. Much of the timber is of small size and yields inferior lumber. The wood supplies a considerable local demand for fuel.

MEXICAN WHITE PINE (Pinus strombiformis).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.4 pounds per cubic foot (Sargent).
Specific gravity.—0.49 (Sargent).
Ash.—0.26 per cent of weight of dry wood (Sargent).
Fuel value.—65 per cent of longleaf pine (Sargent).
Breaking strength (modulus of rupture).—10,800 pounds per square inch, or 61 per cent that of longleaf pine (Sargent).
Factor of stiffness (modulus of elasticity).—1,154,000 pounds per square inch, or 54 per cent that of longleaf pine (Sargent).
Character and qualities.—Light, hard, not strong, close ringed, compact; springwood thin, resinous, not conspicuous; resin passages large, not numerous; medullary rays numerous, obscure; color, light red, the sapwood nearly white.
Growth.—Height, 75 to 90 feet; diameter, 12 to 18 inches.

SUPPLY AND USES.

The Mexican white pine's northern limit is in southwestern Mexico and southern Arizona, and the tree is most abundant at altitudes of from 6,000 to 8,000 feet. Its range extends north and south through

Mexico to Guatemala. In New Mexico and Arizona the growth is scattering and comparatively scarce; the trees are frequently deformed through fire injury, and the trunks are inclined to be limby. Lumbermen who cut it at their mills are disposed to place small value upon it, not because the wood is poor, but because the supply is small. In appearance the wood resembles eastern white pine, but there is no evidence that it ever passes for it or is substituted for the eastern species. It is lumbered and marketed with western yellow pine. For that reason it is difficult to list its uses separately. This pine has contributed its share to the region's fuel supply and ranch timbers; but the demand for these has never been large within the tree's range, because much of the region is mountainous and sparsely settled. The tree is sometimes called ayacahuite pine.

SINGLELEAF PIÑON (Pinus monophylla).

PHYSICAL PROPERTIES.

Weight of dry wood.—35.25 pounds per cubic foot (Sargent).

Specific gravity.—0.57 (Sargent).

Ash.—0.68 per cent of weight of dry wood (Sargent).

Fuel value.—76 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—4,000 pounds per square inch, or 25 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—643,000 pounds per square inch, or 30 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood moderately light, soft, very weak, brittle, grain coarse, often twisted; annual rings narrow, summerwood thin, not conspicuous; resin passages few, not large; medullary rays numerous, obscure; color yellow or light brown, sapwood nearly white; not durable in the soil.

Growth.—Height, 20 to 40 feet; diameter, 12 to 15 inches.

SUPPLY.

The botanical and commercial ranges of this unique tree are coextensive. Wherever it grows it is put to use. The total quantity, considered as timber, is so small that in comparison with some other species, such as western yellow pine or Douglas fir, it is insignificant. Yet it is of such importance that the existence of the population—more in former times than at present—has often depended upon it. It is a product of the desert, of sterile plain, barren ravine, and bleak mountain. It maintains its foothold at an elevation of 9,000 feet, on the eastern slopes of the Sierra Nevada Mountains, and descends to a level of 2,000 feet in the hot Colorado Desert in California. It lives where the mercury falls below zero on wind-swept mountains, and it endures a temperature of 122° in the Mojave Desert. Its range covers portions of Utah, Nevada, California, Arizona, and Lower California, the most sterile and arid regions that can be found in this country. For that reason it has few neighbors of the vegetable

kingdom. A few trees associate with it here and there in its range, among them being mountain mahogany, California juniper, yucca, and sometimes a straggling white fir and Jeffrey pine.

It grows very slowly and can never be planted for the purpose of growing timber. A hundred years would be necessary to produce a fence post and 200 years for a railroad tie. Nothing larger than a crosstie need ever be expected, though in exceptionally favorable circumstances a small, short saw log might be produced. The difficulties which beset the seeds and the seedlings before the young pine finds itself safely established in the sterile soil and inhospitable climate are apparent in the fact that scarcely one seed in ten thousand—possibly not one in a million—becomes a tree. The seedling demands shade to protect it from the scorching sun and withering winds, but the parent trees, almost destitute as they are of foliage, afford hardly the shade which a thin lattice work would give. The large trees are so intolerant that they will endure no crowding, and a forest of these trees casts only a pale, penumbrous shade, and in it the seedlings must struggle for their lives, and the struggle ends in death for the most of them.

The tree has several names, but singleleaf piñon has been proposed as best suited, since it is the only pine in this country with single leaves. They are dispersed sparingly over the twig and are curved to a form resembling the old-style shoemaker's sewing awl. It has been described as the tree with awls for leaves. It is perhaps the most fruitful tree in the world, in comparison with the resources and material at its command.

No estimate can be offered of the quantity of singleleaf piñon timber. It is scattered over an area of 100,000 square miles, but pure stands of considerable density are few. It can scarcely be measured in the way other timbers are measured, for few of the trees will yield a single short saw log of small size. The trunks are branched and squat, like sprawling apple trees. They run to limbs and the yield of an acre or a tract would have to be computed as cordwood rather than as saw logs or even crossties. The tree is sometimes called Fremont's nut pine, gray pine, Nevada nut pine, and Mono mast pine.

LOCAL USES.

The uses of the wood of the singleleaf piñon are local. It is seldom or never shipped out of the region where it grows, but in that region it is of supreme importance. Without it the wheels of industry would stop in many a remote locality where a few men are holding out against adverse circumstances in an effort to develop mining claims, or small tracts of ranch, or farm land surrounded by inhospitable wastes.

In a few instances this pine has been used for crossties. Railroads cross the region in a number of directions, and necessity sometimes compels the builders to employ the crooked trunks for temporary ties and for short timbers in trestles. A more important use of the wood is for mine timbers. Short pieces can frequently be employed to advantage in shoring up stopes and strengthening the walls and roofs of tunnels and galleries. Some of the most productive silver mines ever worked in this country, and many gold mines also, have been located in this pine's range, and the miners put it to every use where it could possibly be made to serve. It was, and is, the main dependence for fuel in large districts. It provides heat for boilers that pump the mine shafts and hoist the ores. The cooking, baking, laundry work, and the warming of homes and camps are possible in many places only by utilizing the singleleaf pine that covers the mesas and ridges.

An industry that is important, though not large, is the burning of charcoal. Portable blacksmith shops are carried into remote canyons or high up on mountains where prospectors are developing mines, and the only fuel for sharpening, mending, and tempering tools is the charcoal burned from this pine in the rude pits built near the source of the wood supply. As a charcoal material on some of the most rugged mountains, it sometimes goes to the pit with the western junipers which maintain a foothold on plateaus and ranges so high that even the pine can not grow there, but the charcoal burner brings them together.

The singleleaf pine is not an ideal farm timber, and it would seldom be put to that use if anything else could be had; but the circumstances which cause it to be employed in mines lead also to its use on ranches. Some timber must be had, even on the most unpretentious desert homestead, and the pine is cut for fences and sheds. It serves also for repairing wagons and farm machines.

BY-PRODUCTS.

This tree has one by-product which gives it a peculiar importance. Groves and stands of the singleleaf pine are known locally and not unaptly as "the redman's orchard." Its phenomenal production of fruit has been spoken of. Every year is not a fruitful year, but a failure of crop is unknown, and when good years come, as they do quite often, the yield is tremendous. It has been said that in total production in a good season this pine's nut crop probably exceeds California's wheat crop.[1] As it is a desert tree, growing on wastes and among remote mountains and scattered over tens of thousands of square miles, in regions with few inhabitants or none, very few of

[1] The Mountains of California, p. 222, John Muir.

the nuts go to supply human needs. Possibly one bushel in a thousand is gathered. It is an important article of food with the nomadic Indians who roam through the region, but can scarcely be said to occupy it. They save all the pine nuts they can while the crop is falling, but the harvest is short. During a month or two the Indians live in luxury and for the rest of the year they must depend upon something else, though the region produces little other food that the Indians can appropriate. This statement applies more to the region before white men began to develop it than now. Had the nut crop been continuous during the greater part of the year the region would have supported a large Indian population, but it sufficed for a few weeks only, and famine followed. The Indians stored the nuts to a limited extent, but they could not, or at least did not, lay by enough for the rest of the year.

The opening of the nut season brought Indians from neighboring regions to partake of the bounty. A single Indian—generally the women did the work—would gather 30 or 40 bushels. The harvest time was a perpetual feast. The nuts were roasted or eaten raw. The Indians preferred them roasted because the strong oil in the nuts soon cloys the appetite if eaten raw. The nut gatherers carried on an interesting though not very large commerce with their countrymen outside the nut district. In some instances the nuts were carried 100 miles to be exchanged for fish or some other product that the native traders could use for barter.[1]

The Indians who gather nuts do not confine their commercial transactions to trade with other Indians, but carry on considerable business with white people. The nuts are sold in thousands of stores between San Francisco and Denver, and North and South. They resemble shelled peanuts in size and appearance and are eaten in the same way. No one knows how many bushels are sold yearly, but in the aggregate the quantity would be surprising if known. The nuts are not bought for human consumption only, but where they are plentiful and cheap are fed to horses, which seem to prefer them to grain. Burro pack trains, carrying supplies for sheep herders and miners in the region, sometimes get little other provender for days together.

When the mines at Virginia City, Nev., and elsewhere in that district were booming, long before railroads were within reach, the problem of feeding the thousands of miners was extremely difficult. Ranchmen in California, west of the mountains, were accustomed

[1] An interesting exchange of commodities formerly took place, and possibly has not entirely ceased, between Indian tribes occupying different sides of the Sierras. West of the mountains, in Fresno and Madera Counties, Cal., Indians gathered acorns, and the women, burdening themselves with 2 or 3 bushels each in baskets strapped on their backs, carried them across the Sierras, 125 miles, following almost impossible trails and passing the summit at 12,500 feet. Arriving on the east side, they exchanged the acorns for pine nuts, which they carried home, the journey occupying about 20 days.

to drive hogs slowly across the Sierras during the late summer, arriving in the pine belt about the time the nuts began to fall. The herds fattened two months on the abundant mast and were then ready for market. This occurred in the region of the Mono Indians, and the name Mono mast pine was applied to the tree.[1]

Although the nut harvest in the aggregate is enormous, and a proportion so small as to be almost negligible is ever gathered by man, yet in certain localities former plenty has been changed to little or nothing, due to the cutting of the trees for fuel and mine timbers. The white man's and the Indian's interest clashed many times on the desert frontier, the red man defending his food tree and the white man bent on taking it away.

MEXICAN PIÑON (Pinus cembroides).

The Mexican piñon has its northern limit in southern Arizona and New Mexico, where the trees are comparatively numerous, but so small that they contribute scarcely any saw timber, though something to the region's fuel supply and to the needs of ranches. Its average height is only about 30 feet and its diameter less than 1 foot. The nuts have hard shells, like those of gray pine, and are edible. The tree is sometimes called nut pine, piñon, and stone-seed Mexican piñon. The wood is light, soft, very close ringed, compact; bands of small summer cells thin, not conspicuous, resin passages few, small; medullary rays numerous, obscure; color light, clear yellow, the sapwood nearly white. The wood's weight is 40.58 pounds per cubic foot, specific gravity 0.65, and ash 0.9 per cent of dry weight of wood. (Sargent.)

PIÑON (Pinus edulis).

PHYSICAL PROPERTIES.

Weight of dry wood.—39.8 pounds per cubic foot (Sargent).

Specific gravity.—0.64 (Sargent).

Ash.—0.62 per cent of weight of dry wood (Sargent).

Fuel value.—85 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—6,300 pounds per square inch, or 39 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—604,000 pounds per square inch, or 29 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood heavy, hard, weak, brittle; annual rings very narrow; summerwood thin, not conspicuous; resin passages few, small; medullary rays numerous, obscure; color, light brown, the sapwood nearly white; moderately durable in contact with the soil.

Growth.—Height, 10 to 25 feet; diameter, 6 to 20 inches.

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[1] The herding of the hogs on the pine mast was often attended with danger. The Indians of the immediate vicinity resented the invasion, and with reason, since their food supply was being devoured by the hogs. They retaliated by stealing as many of the swine as possible, and sometimes offered violence to the herders. Bears of large size and savage nature also left off gathering nuts and fell upon the swine with appetites so voracious that the herders were compelled to wage constant war upon the marauders.

SUPPLY AND USES.

This pine has several names, all of which are based on the fruit it bears. It is called nut pine, piñon pine, piñon, and New Mexican piñon, and is one of the four pines of the far West whose nuts are important as food, the others being the singleleaf piñon, the Parry pine, and the Mexican piñon. The tree under consideration has its range in Colorado, New Mexico, and western Texas. It grows to an elevation of 9,000 feet or more, and the available supply is considerable, though it can scarcely be classed as a timber tree in the ordinary meaning of the term. Its trunk is so short that it seldom makes more than a crosstie or fence post. It usually branches a few feet above the ground, and has the appearance of a large shrub.

The piñon has been tested as tie timber and as such has had a limited commercial use. Some 20 years ago the Rio Grande Western Railroad laid 2,000 piñon ties as an experiment, and the result was believed to be satisfactory. In some other instances where this wood has been similarly used ties occasionally broke under the strain of traffic, the rails cut the wood, and sometimes, with resinous specimens, the ties split when spikes were driven. Complaint has also been made that the wood's holding power upon spikes is poor.

Reports are conflicting also with regard to the value of this wood for fence posts, of which comparatively large numbers are used. Sometimes they have offered satisfactory resistance to decay, and at others have lasted only 3 or 4 years. This difference may be explained by the fact that some of the timber is very pitchy and some is not. The posts for an experimental coyote-proof pasture fence in Cochetopa National Forest, Colo., are of this timber.

In all parts of the tree's range it is cut for fuel. Where the demand is strong large areas have been partly or wholly stripped to supply it. In some parts of Colorado $8 a cord has been paid for it. Few softwoods rank above it in fuel value.

Telephone poles are sometimes cut of piñon, but on account of its poor form its use as poles can never rise to importance.

Charcoal burners in all parts of its range have cut it for fuel for local forges. The wood is pressed into service for various ranch uses, usually because it is the best available in particular localities. Among such uses are parts of wagons and sleds, neckyokes, pickets, corral poles and posts, culverts, sheds, and cabins.

The nuts borne by this tree give it one of its chief values. The Indians and some of the early settlers of the region gathered the nuts for food. This is still done to some extent, and local stores offer them for sale. The tree is a less prolific seeder than is the singleleaf piñon of eastern California and western Nevada. The nuts are not carried by the wind, but fall near the trunk of the parent tree, where they are easily collected by Indians and by birds and rodents. So

few escape that reproduction is scanty in most localities, and that fact will have its influence upon the future supply of this species.

PARRY PIÑON (Pinus quadrifolia).

PHYSICAL PROPERTIES.

Dry weight of wood.—35.4 pounds per cubic foot (Sargent).

Specific gravity.—0.57 (Sargent).

Ash.—0.54 per cent of weight of dry wood (Sargent).

Fuel value.—76 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—6,400 pounds per square inch, or 40 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—565,000 pounds per square inch, or 27 per cent that of longleaf (Sargent).

Character and qualities.—Wood moderately heavy, soft, compact; annual rings very narrow; summerwood thin, not conspicuous; resin passages very numerous, large, conspicuous; medullary rays numerous, obscure; color light brown or yellow, the sapwood much lighter.

Growth.—Height, 15 to 30 feet; diameter, 10 to 16 inches.

SUPPLY AND USES.

The Parry piñon's range is confined to the extreme south of California and to Lower California, but it is more abundant south than north of the international boundary. It is too small a tree to figure largely in lumber production, even if it were plentiful. It is cut for fuel, and a little is employed about ranches for fencing, posts, and for repair of farm implements. The Indians of the region, and occasionally the Americans, make use of the large nuts for food. The seeds are wingless and seldom get themselves planted far from the parent tree. It is not probable that this pine will ever become more important than it is now.

MONTEREY PINE (Pinus radiata).

PHYSICAL PROPERTIES.

Dry weight of wood.—28.5 pounds per cubic foot (Sargent).

Specific gravity.—0.46 (Sargent).

Ash.—0.3 per cent weight of dry wood (Sargent).

Fuel value.—61 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,000 pounds per square inch, or 62 per cent that of longleaf pine (Sargent).

Factor of siffness (modulus of elasicity).—1,415,000 pounds per square inch, or 67 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood light, soft, strong, and rather tough; annual rings very wide; summerwood not broad, resinous, conspicuous; color, light brown, the very thick sapwood nearly white.

Growth.—Height, 70 to 90 feet; diameter, 18 to 30 inches.

SUPPLY AND USES.

The Monterey pine's range is restricted to the California coast, south of San Francisco, and to the islands adjacent. It will grow in pure stands, but it does not live long in arid situations, nor does it thrive in wet soils. It can, however, grow in the shade, and it is not

forced to retreat before other trees. This characteristic will be important if the tree should ever be planted for timber. It grows as rapidly as the loblolly pine of the east, the annual rings sometimes being nearly an inch broad, and trees from 28 to 35 years old are 16 to 18 inches in diameter. It commonly attains a height of from 70 to 90 feet, but the largest trees are taller than this, and sometimes attain a diameter of 6 feet. The tree has been planted for ornament and shelter belts, and a portion of the small quantity of its wood that has been used has been cut from planted trees. It is employed as fuel, a little lumber is occasionally sawed from it, and a small amount finds place as ranch timber near the coast. The tree bears abundance of seeds, but the cones remain closed from 6 to 10 years.

COULTER PINE (Pinus coulteri).

PHYSICAL PROPERTIES.

Weight of dry wood.—25.8 pounds per cubic foot (Sargent).

Specific gravity.—0.37 (Sargent).

Ash.—0.37 per cent of weight of dry wood (Sargent).

Fuel value.—55 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,700 pounds per square inch, or 66 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,622,000 pounds per square inch, or 77 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, moderately strong, very tough; annual rings narrow, summerwood broad, resinous, conspicuous; resin passages few, large; medullary rays numerous, prominent; color, light red, the thick sapwood nearly white.

Growth.—Height, 40 to 70 feet; diameter, 18 to 30 inches.

SUPPLY AND USES.

The Coulter pine is confined to the coast regions of California, between San Francisco Bay and the Mexican line. It never occurs in pure stands, and the available supply is small. The tree bears considerable resemblance to the western yellow pine, but is much inferior in size. Trunks of 10 or 15 feet length are rare, and diameters of from 18 to 30 inches are a fair average. In size of cone this pine surpasses all others, and the cones are further remarkable for the sharp, hooked claws on the ends of the scales. It is not an aggressive tree, and does not push with vigor into vacant spaces, but holds the ground fairly well which it already has. It need not be expected that it will ever exercise much influence upon the lumber supply of the region where it grows. In some localities its short trunk has been sawed into rough lumber for fences, barns, sheds, and irrigation flumes. A larger amount has gone into cordwood, and for that use it is fairly profitable when accessible to market. Its fuel value is a little under that of western yellow pine. It was once burned in pits for charcoal to supply local blacksmith shops, but it is seldom put to that use now. It is known as Coulter pine, nut pine, big cone pine, and large cone pine.

TORREY PINE (Pinus torreyana).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.4 pounds per cubic foot (Sargent).

Specific gravity.—0.49 (Sargent).

Ash.—0.35 per cent weight of dry wood (Sargent).

Fuel value.—68 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,600 pounds per square inch, or 66 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—803,000 pounds per square inch, or 38 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood, light, soft, moderately strong, very brittle, compact; bands of small summerwood broad, resinous, conspicuous; resin passages small, few; medullary rays numerous, obscure; color, light red, the sapwood yellow or nearly white.

Growth.—Height, 18 to 30 feet; diameter, 8 to 15 inches.

SUPPLY AND USES.

The range of the Torrey pine is restricted to a small portion of San Diego County, Cal., and to the islands of Santa Cruz and Santa Rosa. The species is rapidly disappearing, the small supply upon the mainland having been drawn upon for fuel and for local use on ranches until little remains. It is sometimes called the Soledad pine—" pine of solitude." Where it grows in the sweep of sea winds its usual height is from 25 to 35 feet, with a diameter from 8 to 14 inches, but in sheltered situations it forms a fairly straight trunk from 40 to 60 feet or more high and is fit for small saw timber. It is so scarce, however, that it is seldom cut.

GRAY PINE (Pinus sabiniana).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.2 pounds per cubic foot (Sargent).

Specific gravity.—0.48 (Sargent).

Ash.—0.4 per cent weight of dry wood (Sargent).

Fuel value.—65 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—10,800 pounds per square inch, or 67 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—830,000 pounds per square inch, or 39 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood light, soft, rather strong, but brittle; annual rings generally wide; the wood of isolated trees is coarse and twisted grained, the wood of closely grown timber is much finer and softer; summerwood broad, very resinous, resin passages few, large, prominent; medullary rays numerous, obscure; not durable in contact with the soil.

Growth.—Height, 50 to 70 feet, but sometimes 100 or more; diameter, 18 to 30 inches, with occasional trees more than 3 feet.

SUPPLY.

This tree is generally called digger pine in the region where it grows, but in literature it is known as gray pine, grayleaf pine, and Sabine's pine. Its range is in the form of an elipse 500 miles long

and 150 wide, a band or rim surrounding the central California Valley. Its northern limit is near Mount Shasta, its southern near the Mojave Desert. The timber does not descend into the valley region of California, but grows as a fringe on the hills and mountains on all sides of it. It actually occupies some 30,000 or 40,000 square miles, but the stand is scattered and the total quantity comparatively small. It is seldom fit for or counted as saw timber. The trunks go to limb and are thick rather than tall. In many instances this is due to the loss of the leader or topmost shoot, through attack of two microscopic fungi, *Peridermium harknessi* and *Dædalia vorax*.

Gray pine appears to be holding its own in most parts of its range. It grows rapidly under circumstances by no means favorable, and for that reason it is worth caring for. It endures drought, sometimes severe enough to kill the chaparral and oaks associated with it. Parched and sterile soils afford it nourishment, but it responds to better conditions, and a few years bring it to size fit for mine props and cordwood, while a period of 85 years has been known to produce timber 90 feet high and 46 inches in diameter. The extreme recorded age of this pine is 175 years. Better fire protection is doing much to encourage its reproduction and growth. Seedlings are more numerous than formerly, and though it is a light-demanding tree, it thrives in tolerably dense stands, which produce a better kind of wood—softer and finer—than open stands and straggling growths. Seeds do not plant themselves far from the parent tree, because they are heavy and have very small wings. This places them at a further disadvantage, for seed eaters, be they bird, beast, or human, can easily find the large, chocolate-colored nuts where they fall. Herds of hogs roaming the pine belts are the greatest enemies of this pine, next after fire. If tree seeds are worth 5 cents a pound, a hog turned loose to forage on wild mast will devour several times his own value in a single season. The portion of its range lying in National Forests, where fire and hogs are held in check, shows promising young growth of seedlings. Where within the habitat of the gray pine the foothill oaks have been cut for fuel, and reproduction has almost ceased, the pine is gaining and in time its importance as a fuel supply will be recognized.

This pine will, it is believed, produce saw timber if given a chance on soils fairly good. In parts of California where it grows on adobe soil the wood is willingly accepted for mine props, both on account of strength and durability.

EARLY USES.

The first settlers in California soon came in contact with gray pine, which grew just above the oaks of the valleys, lower canyons, and foothills. Oak was preferred for fuel where it was convenient,

not because it made a better fire than the pine, but because it was easier to cut. The fibers of gray pine are interlaced and bound together, the wood is split with great difficulty, and chopping is a slow process. For that reason the early woodcutters preferred oak until it became scarce. The pine could be had in poles and logs of greater length and of more shapely form than oak, and was preferred for fencing, corrals, and sheds. As long as placer mining prevailed little timber was needed, but when quartz mines began to be opened, props and frames were in demand. Gray pine at once rose to a place of importance, because in many instances it was more plentiful than any other timber. Tunnels were braced and roofed with it. The wood quickly decays, but commonly that was not a serious drawback, for a mine was often worked out in a few months, or within that space of time the prospector would discover that it was unprofitable and abandon it. Another important use of this wood for mining purposes came with the introduction of the steam engine to take the place of the arrastra, or stone drag, of early days. The engine demanded fuel, and though all kinds went to the furnace, gray pine was often most plentiful, and therefore most important. In many mining districts it was stripped clean for miles. Not infrequently it was carried on the backs of burros, with peculiarly constructed pack saddles, over narrow trails where sleds and wheeled vehicles could not be taken. In two ways the pine was economical for steam engines in remote mines—it was light in weight and made more heat than an equal weight of oak.

Fence posts of this pine were frequently set when other woods were not convenient, but it was poor material. A mass of fungus would appear at the surface of the ground within three or four months after rain had dampened the wood, and in a very short time the post would rot off. Split posts gave no better service than round. An average of cost and term of service for posts of three woods, in the San Joaquin Valley, Cal., gives for redwood 25 cents each, with from 20 to 25 years' service; incense cedar, 20 cents and from 15 to 20 years' service; gray pine, 10 cents and from 1 to 2 years' service.

The wood of this pine was long preferred for ox yokes in the lumber regions of California. Plow beams were once, and still occasionally are, made of it; and it gives satisfaction for wagon bolsters in local shops and factories.

MANUFACTURE AND PRODUCTS.

Efforts up to this time to give gray pine posts preservative treatment to retard decay have not produced satisfactory results. The oleo-resin of this wood does not permit creosote to enter deeply or easily, and more experimenting seems necessary before a cheap and effective process of treatment can be put in practice to make the wood available for fence posts.

It is believed that if gray pine is permitted to grow in good soil and in fairly dense stands it will produce saw timber of considerable value. It has been manufactured, on a small scale, in some parts of the Coast Range, and early settlers on Huer Huero Creek, a tributary of Salinas River, built their cabins of gray-pine lumber. Experience has shown that saw logs should be peeled at once after felling, and ought to be converted into lumber within a month or two. The seasoning should take place in the shade, and heavy weights should be piled on the boards to prevent warping. A fair second-grade lumber will result.

BY-PRODUCTS.

Many chemists in Europe and America have been interested in the resin or turpentine produced by the gray pine. A single manufacturer placed an order for 500 barrels; and several years ago the Alaska Fur Company bought the entire output of a small distilling plant at North Fork, Madera County, Cal. The plant distilled about 20 barrels a year of high-grade turpentine from large roots. The plant burned down about 15 years ago, and manufacturing at that place stopped.

There are two flowing seasons for this tree in the Sierra Nevadas. One opens very early, and closes when the weather grows hot; the other is in full current by the middle of August. The trees are so scattered and of so many sizes that the profitable gathering of turpentine will be difficult. It is said that to procure 500 barrels 50,000 trees must be tapped, and this number of trees can be found only by covering large areas.

The seeds of the gray pine are of local value for food, though not in the same degree as those of the singleleaf pine east of the Sierras. The gray-pine nuts have hard shells and must be broken by force before the kernels can be extracted. The Indians gather them in the fall. Next to the Coulter pine, this tree's cones are the heaviest of all American pines.

WHITE BARK PINE (Pinus albicaulis).

PHYSICAL PROPERTIES.

Weight of dry wood.—26 pounds per cubic foot (Sargent).[1]

Specific gravity.—0.42 (Sargent).

Ash.—0.27 per cent of weight of dry wood (Sargent).

Fuel value.—56 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—8,150 pounds per square inch, or 51 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—729,000 pounds per square inch, or 34 per cent that of longleaf pine (Sargent).

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[1] The weight, specific gravity, ash, fuel value, breaking strength, and factor of stiffness were calculated from a single specimen of the wood which grew on the Frazer River, British Columbia.

Character and qualities.—Wood light, soft, brittle, compact, annual rings very narrow, grain fine, but nearly always twisted; summerwood thin, not conspicuous; resin passages numerous, not large; medullary rays numerous, obscure; color pale brown, sapwood nearly white and very thin.

SUPPLY AND USES.

The white bark pine's range covers parts of Montana, Idaho, Washington, Oregon, Nevada, Arizona, and California. The color of the bark gives the name, but it is also called white stem pine, scrub pine, pitch pine, white bark, creeping pine, and alpine white bark pine. These names are descriptive.

If this tree grew in a region of abundant timber supply it would be considered of no importance, because of its scarcity and its gnarled and unshapely form. It is not of great importance in the region where it is found, though it is sometimes the only tree to be seen on bleak mountains, just below perpetual snow. Occasionally, however, a miner, camper, sheep herder, or traveler makes use of it to supply his urgent wants when no other wood can be had. It is one of the three or four most enduring mountain trees of the United States. It grows at elevations of from 5,000 to 10,000 feet in Idaho and Montana, and in California ranges to 10,000 and 11,000 feet. Growing commonly in pure parklike stands at extreme altitudes, at its lower range it has for associates alpine fir, Engelmann spruce, Lyall larch, limber pine, and lodgepole pine. It survives a temperature sometimes 60° below zero and storms that render most other forms of vegetable life impossible. Its own seedlings frequently perish, not from cold or drought, but because the wind thrashes them against the rocks that surround them and wears them to pieces. Those that survive are apt to take on shapes little resembling trees, but rather like vast, green spiders a hundred feet in circumference that seem sprawling over the rocks. This applies only to the highest and most exposed mountains; for the tree has a wide range, and in some parts of it the timber is of fairly respectable size and form. In the Mono Basin, east of the Sierras in California, fence posts are sometimes cut from the white bark pine; and in other localities a little fencing material is procured, while in every part of its range, along the mountains from British Columbia to Mexico, it makes fuel for those who live in or pass through the region where it grows.

On the Clearwater and Nez Perce National Forests the species is found in merchantable size over rather large areas at altitudes of from 5,000 to 6,800 feet. The trees are about 40 feet high and have a merchantable length of 24 feet. Similar growth is reported in places in Montana.

On high mountains where the snowfall is heavy the limbs of this tree may extend 20 feet or more and lie on the ground like creeping vines. The snow holds them down during half of the year, and they can not rise when the weight is removed. Wild sheep, deer, bears,

and other animals understand the value of the recumbent branches in time of severe weather and creep beneath them for shelter. Travelers, overtaken by storms, have done the same, and it is thus apparent that the uses of this tree are not confined to what may be done with the wood when it is cut.

The slow growth of the white-bark pine, particularly in the most exposed situations, may challenge comparison with the trees of slowest growth anywhere. Trunks $3\frac{1}{2}$ inches in diameter may be 225 years old; one 6 inches through had 426 rings; while one 17 inches in diameter was over 800 years old and less than 6 feet high. By the aid of a magnifying glass John Muir counted 75 rings in a branch one-eighth inch in diameter. Such a branch is so tough and so pliant that it may be tied in a knot like a cord. Muir said that he knew of only two trees which are never uprooted by the wind—the white-bark pine and the mountain juniper, which is associated with it in the Sierra Nevada Mountains.[1] Though the white-bark pine may never be wind thrown, trunks with roots and branches attached are sometimes found at the base of precipices, on the summits, or against the sides of cliffs where they once grew. The breaking away of the rock, by freezing or otherwise, may have thrown them down. Such an accident sometimes furnishes fuel for a mountain traveler's night camp where otherwise he would sleep without fire. Some of these trunks and roots, when the branches have been broken off, are of such strange form that a rather close examination may be necessary to determine which end grew upward.

It need scarcely be said that man will never do much to help or hinder the growth or existence of this tree. Even forest fires seldom touch the white-bark pine. It grows among rocky masses where fire finds so little fuel that it can not go. The tree plants its seeds within a few inches of where they ripen and fall. They come wingless from the cones. It seems that nature's handicap begins even before the seed makes its escape from the inclosing scales, for the short wing that might be supposed to aid the seed in finding a place to be planted grows fast to the scale and holds the seed until it can free itself by tearing its wing off, when it falls to the inhospitable rocks or sterile soil beneath. Under such adverse circumstances it is too much to expect the white-bark pine to extend its range or to increase its importance. The wonder is that it is able to hold its own.

In its best growth the wood of white-bark pine much resembles that of white pine. Where it grows in size to give a clear length of from 20 to 30 feet, it should serve fairly well for rough construction material in the form of building logs, mine props and stulls, bridge timbers, fence posts, and for fuel. The seeds are used by Indians as food.

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[1] Mountains of California, by John Muir.

LIMBER PINE (Pinus flexilis).

PHYSICAL PROPERTIES.

Weight of dry wood.—27.2 pounds per cubic foot (Sargent).

Specific gravity.—0.44 (Sargent).

Ash.—0.28 per cent of weight of dry wood (Sargent).

Fuel value.—60 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—8,700 pounds per square inch, or 54 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—937,000 pounds per square inch, or 44 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood light, soft, narrow-ringed, compact; summerwood narrow, not conspicuous; resin passages numerous, large; medullary rays numerous, conspicuous; color light, clear yellow, changing to reddish on exposure, the sapwood nearly white.

Growth.—Height, 30 to 50 feet; diameter, 12 to 36 inches.

SUPPLY.

The limber pine is known also as white pine, bull pine, Rocky Mountain white pine, and limber-twig pine. Its drooping limbs are long, slender, and flexible, hence its name. It ranges from Canada southward along the Rocky Mountains to New Mexico and extends westward into Arizona and California. In the Sierra Nevadas the upper limit of its range is 12,000 feet. In the Rockies, at the lowest range of this tree's growth and from 4,000 to 6,000 feet elevation, it forms open, scattered stands of round-topped, stunted trees of no commercial value, usually in company with Rocky Mountain red cedar or western yellow pine. At timber line—from 8,500 to 10,000 feet—it assumes a similar or even more stunted form, associating with Lyall larch or other alpine species. At intermediate elevations it occasionally produces merchantable timber in company with Douglas fir, and possibly also with white-bark pine, lodgepole pine, Englemann spruce, and alpine fir.

It is, or was once, the most important timber tree of central Nevada, but in many districts it has been cut clean to supply mine timbers, rough lumber, fuel, fencing, and charcoal. It forms a small proportion of the merchantable stand in the Gallatin and the Lewis and Clark National Forests, in company with Douglas fir, lodgepole pine, and white-bark pine. It is a tree of slow growth. Its seeds are practically wingless, and reproduction is restricted to the immediate vicinity of the parent.

It is commonly a low, thick-trunked, much-branched tree, usually between 25 and 50 feet high, with a trunk anywhere from 5 inches to 3 feet in diameter. In its usual habitat the tree is so stunted and the trunk so short as to yield no merchantable logs. In better locations, however, it is possible to cut 10-foot or even longer logs. When mixed with other species in sheltered canyons it is a tall, straight tree, in shape somewhat similar to lodgepole pine. As compared with

white bark pine, when grown in the same situations, the limber pine has the longer, straighter trunk of the two.

USES.

It is seldom that the quality of the wood of this pine is sufficiently good for saw timber, and even then a good proportion will be very knotty. Frequently large trees show decay at the heart. When logs fairly clear and sound can be procured the lumber is suitable for window frames and interior finish. In the Rocky Mountains this wood is among the best native species for flooring, when sufficiently clear for that use; but very little of the grades demanded for flooring or finish ever reaches market, and what does go to market is listed simply as pine, and the purchaser seldom knows the exact species he is using.

When green the wood is extremely heavy, and if left in water any length of time will sink. After being seasoned, however, it becomes extremely light. At a sawmill which formerly operated on Dupuyer Creek, on the Lewis and Clark National Forest, it was found that limber pine could be manufactured into a good grade of lumber and shingles. The stem of the tree was generally free from defects and knots and could be used for the better grades of finishing lumber. This limber pine had grown mixed with a heavy stand of Douglas fir in a sheltered canyon, and the trees had grown tall and straight. It is seldom, of course, that the quality of the wood can be found as good as that on Dupuyer Creek. In its most common form of growth limber pine is useful only for fence posts and for fuel. The posts are nearly always very knotty and are often of undesirable shape. The wood holds staples well for wire fence, and is durable in contact with the ground, though it is not considered as long lasting as bristle-cone pine when set as posts.

A very unique method of securing a preservative treatment of limber and white-bark pine timber for fence posts is practiced by ranchers in the vicinity of the Madison National Forest, in Montana. A sapling growth the size of the posts desired is selected, and in the spring as soon as the sap runs freely so that the bark will slip, the rancher peels the bark from the standing tree for the length to be used. The tree immediately exudes a sufficient quantity of resin to cover the wound and dies. Six or eight months later the rancher cuts the tree, now thoroughly seasoned, smears the cut ends with tar, and has a post impervious to water and immune to insects or fungus. Posts so treated are said to last many years. One lot was examined which had been set for 20 years, and the posts seemed as sound as ever.

Railroads within reach of this pine buy ties made of sound, fire-killed timber. Miners employ the wood for props, posts, and other timbers, both above and below ground. It is used in mountain roads

and trails for bridges and corduroy. It makes good charcoal. Limber pine has proven the most resistant of any species to sulphurous fumes from copper smelters on the Deerlodge National Forest. It has continued to make thrifty growth where all other species have died from the fumes.

CALIFORNIA SWAMP PINE (Pinus muricata).

PHYSICAL PROPERTIES.

Weight of dry wood.—30.8 pounds per cubic foot (Sargent).

Specific gravity.—0.49 (Sargent).

Ash.—0.26 per cent of weight of dry wood (Sargent).

Fuel value.—66 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—14,000 pounds per square inch, or 87 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,652,000 pounds per square inch, or 78 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood, very strong and hard, compact; summerwood broad, resinous, resin passages few, not prominent; medullary rays numerous, thin; color, light-brown, the thick sapwood nearly white.

Growth.—Height, 45 to 90 feet; diameter, 12 to 24 inches.

SUPPLY AND USES.

California swamp pine is not abundant and its uses are few, yet the tree has characteristics which give it local importance. It occurs near the California coast, from 100 miles north of San Francisco to 200 miles south. In the southern part of its range it is sometimes cut for fuel and for small farm timbers, and in the north it is occasionally employed for skids, rough bridges, and scaffolds in lumber operations. It grows in the vicinity of redwood forests, and in cutting that timber some of the pine is made use of. The seeds blow into the openings where the redwood is cut, and in some localities it is taking possession of the ground. It occupies such soils as it finds vacant, and will grow in cold clay, in peat bogs, on barren sand or gravel, and on wind-swept ridges exposed to ocean fogs. It thrives in full sunlight, or it will grow in shade. Its ability to grow where few other trees can maintain themselves promises some future usefulness, though it is not probable that it can ever be of much importance. The wood is very strong and hard. The tree is known by several names, among them dwarf pine, pricklecone pine, bishop pine, and obispo pine ("bishop" being the English equivalent of the Spanish word "obispo").

KNOBCONE PINE (Pinus attenuata).

PHYSICAL PROPERTIES.

Weight of dry wood.—21.8 pounds per cubic foot (Sargent).

Specific gravity.—0.35 (Sargent).

Ash.—0.33 per cent of weight of dry wood (Sargent).

Fuel value.—47 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—5,730 pounds per square inch, or 36 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—616,000 pounds per square inch, or 29 per cent that of longleaf pine (Sargent).

Character and qualities.—Light, soft, not strong, brittle; annual rings narrow, due to slow growth; summerwood narrow, not conspicuous; resin passages numerous, large, prominent; medullary rays numerous, thin; color light brown, the thick sapwood nearly white, or slightly tinged with red.

Growth.—Height, 25 to 40 feet; diameter, 8 to 12 inches, though much larger in favorable situations.

SUPPLY AND USES.

Knobcone pine is not a valuable timber tree. It sometimes is cut for fuel and has a few minor uses about ranches and mines, but it is too small and too scarce to become important. It grows in dry mountain regions in Oregon and California, and in exceptionally favorable situations yields small saw timber or good-sized mine props. Like the jack pine of the Lake States, it is short lived, even when no accident overtakes it, but it usually falls a victim to fire. It prepares for an early death by producing cones when from 5 to 8 feet high. Miners once called the tree hickory pine, not because the wood was tough like hickory, but because it was white. A difference of opinion exists as to its toughness, some claiming uses for it on account of that property, while others say the wood is brittle. The latter quality is indicated by the tests which have been made. The cones are so persistent that not infrequently the tree is unable to crowd them off, and they become embedded in the wood. The cones seldom open to release the seed, and a tree may retain the accumulated crops of nearly its whole life, which may amount to 3 or 4 pounds of seed. Then a fire kills the tree, the cones open, and the wind scatters the small black winged seeds upon the bared mineral soil. Seedlings must have light, however, or they will not last long, and this characteristic has given the tree the names " sun-loving pine " and " sunny slope pine." Although the fuel value of the wood is very low, more is used for fuel than for any other purpose.

BRISTLECONE PINE (Pinus aristata).

PHYSICAL PROPERTIES.

Weight of dry wood.—34.7 pounds per cubic foot (Sargent).

Specific gravity.—0.56 (Sargent).

Ash.—0.3 per cent of weight of dry wood (Sargent).

Fuel value.—75 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—9,100 pounds per square inch, or 57 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—1,032,000 pounds per square inch, or 49 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood moderately light, soft, not strong, very narrow ringed, compact; grain fine and usually twisted; summerwood thin, dark-

colored, conspicuous, resinous; resin passages few, not prominent; medullary rays numerous, obscure; color reddish, the thin sapwood nearly white.

Growth.—Height rarely exceeding 40 feet or diameter more than 3 feet, usually much smaller.

SUPPLY AND USES.

The bristlecone pine, so named because of the sharp bristles on the ends of the cone scales, is a high-mountain tree, running up to the timber line at an altitude of 12,000 feet, and seldom occurring below 6,000 or 7,000 feet. It ekes out its existence in many regions on dry, stony ridges, very cold and stormy in winter and subject to protracted drought during the growing season. Under such conditions a large and symmetrical tree is impossible, and the bristlecone pine's trunk is short, excessively knotty, and tapers rapidly. It reaches its best development among the Rocky Mountains, but extends its range westward to the mountains of California, and is found in Utah, Nevada, and northern Arizona. It grows slowly and reaches an age of 200 years or more.

The great altitude at which it grows and the remoteness of the districts where it abounds would exclude it from many of the common uses. In addition to that disadvantage, it is not desirable in either form or quality. Yet in spite of these drawbacks it has been and still is important in certain localities. Many valuable mines in central Nevada were developed largely through the use of this unshapely tree. In some sections it was cut so closely that scarcely a seed tree was left. It was made to serve as mine props, stulls, lagging, windlass frames, cabins, fuel, and other necessary accessories to mining. It was sometimes the best charcoal wood obtainable, and the product of the pits was carried long distances on pack animals to supply blacksmiths in mining camps.

It is rarely sawed into lumber, but is occasionally employed as fence posts, the resin in the wood causing it to give fairly long service. Its use as railroad ties has been reported, but it is not listed as tie material by any of the leading railroads. It finds place in the construction of stock corrals, sheds, fences, and sometimes barns and cabins. The grain of the wood is so involved and twisted, and so many knots abound, that no split commodities, such as shingles, shakes, or pickets, can be made from it.

There is no likelihood that the bristlecone pine will ever rise to an important place in the country's lumber supply, but it is perhaps the most valuable crop that the sterile and rocky peaks and ridges will produce. It crowds out no tree that is more valuable, and it is able to maintain its existence. Its small seeds have ample wing area, and the wind carries them to a distance of 600 feet or more from the parent tree. They take root and grow in rocky soil where no humus is visible.

FOXTAIL PINE (Pinus balfouriana).

PHYSICAL PROPERTIES.

Weight of dry wood.—33.9 pounds per cubic foot (Sargent).

Specific gravity.—0.54 (Sargent).

Ash.—0.4 per cent of weight of dry wood (Sargent).

Fuel value.—73 per cent that of white oak (Sargent).

Breaking strength (modulus of rupture).—5,900 pounds per square inch, or 37 per cent that of longleaf pine (Sargent).

Factor of stiffness (modulus of elasticity).—846,000 pounds per square inch, or 40 per cent that of longleaf pine (Sargent).

Character and qualities.—Wood moderately light, soft, weak, brittle; annual rings very narrow, compact; summerwood very narrow, dark-colored; resin passages few, not conspicuous; medullary rays numerous, obscure; wood satiny and susceptible of a good polish.

Growth.—Height, 30 to 50 feet: diameter, 10 to 16 inches.

SUPPLY AND USES.

This tree is occasionally called spruce pine. It is confined to California and to a few of the high mountain regions. It is too scarce to be of much importance as a source of lumber, yet it is sometimes cut where it is associated with other species near the lower limits of its range. Trees are small and knotty, but when a clear stick is found the wood is compact and susceptible of a good polish. Its growth is slow. Where the tree is at its best it attains a diameter of about 18 inches in 300 years and a height of 60 feet or less. In the higher parts of its range it is too small, ragged, and dispersed to have value other than as fuel, and not much for that, since few people live in those regions. It grows at an elevation of 13,000 feet near Farewell Gap, in the Sierras, and few species, if any, in this country equal it for altitude. Within its range it is frequently the upper fringe of the timber line, its nearest neighbors being the white-bark pine and western juniper. This pine's seeds, unlike those of the white-bark pine, escape with their wing from the cone and are widely scattered by wind, thus assisting the tree to maintain its position in regions which otherwise would have little or no timber of any kind. Sheep herders, miners, tourists, and others who spend the summer among California's highest mountains are often indebted to the foxtail pine for their camp fuel. Near the upper limit of its range the tree frequently dies at the top—which is often not much above a man's height—and the dry wood, which is barked by the wind and bleached and whitened by sun and age until it resembles bone more than wood, is gathered by breaking off the dry branches.

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